STANDARD SPECIFICATIONS
For
ROAD AND BRIDGE
CONSTRUCTION

1995 Edition

Adopted by

The
Montana Department Of Transportation
and the
Montana Transportation Commission

Number _____

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For copies of the 1995 Standard Specifications for Road and Bridge Construction write:

Montana Department Of Transportation
Contract Plans Section
2701 Prospect Avenue
P.O. Box 201001
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Department of Transportation

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SECTION 101
DEFINITIONS AND TERMS

101.01 GENERAL. The Standard Specifications are written to the Contractor. They define the Contractor's responsibility in meeting each specification. The short sentences, written in the active voice, explain what the Contractor must do. The Specifications outline the expectations of the Department, and explain what the Contractor shall provide the Department. Unless otherwise noted, all actions are to be performed by the Contractor. "Will" statements mean the Department or Engineer is responsible or will perform the action.

The active voice writing style is recommended by the Federal Highway Administration Technical Advisory 5080.16. Examples of the writing styles are as follows:

Passive Voice: The Contractor shall construct the temporary detour as specified in the Contract.

Active Voice: Construct the temporary detour as specified in the Contract.

The titles and headings of the sections, subsections, and sub-parts are for the convenience of reference and do not necessarily have a bearing on their interpretation.

When a publication is specified, it refers to the most recent date of issue, including interim publications, before the date of bid receipts for the project unless the issue of a specific date or year is specified.

Whenever the following abbreviations and terms are used in the Contract, the intent and meaning is interpreted as follows:

101.02 ABBREVIATIONS.

AA - Aluminum Association
AAN - American Association of Nurserymen
AAR - Association of American Railroads
AASHTO - American Association of State Highway and Transportation Officials
ACI - American Concrete Institute
AGC - Associated General Contractors of America
AIA - American Institute of Architects
AISC - American Institute of Steel Construction, Inc.
AISI - American Iron and Steel Institute
ANSI - American National Standards Institute, Inc.
ARA - American Railway Association
AREA - American Railway Engineering Association
ARTBA - American Road and Transportation Builders Association
ASCE - American Society of Civil Engineers
ASLA - American Society of Landscape Architects
ASME - American Society of Mechanical Engineers
ASTM - American Society for Testing and Materials
AWPA - American Wood Preservers Association
AWS - American Welding Society
AWWA - American Water Works Association
FHWA - Federal Highway Administration
FSS - Federal Specifications and Standards

GSA - General Services Administration
IES - Illuminating Engineering Society
IMSA - International Municipal Signal Association
ITE - Institute of Transportation Engineers
MCA - Montana Code Annotated
MDT - Montana Department of Transportation
MIL - Military Specifications
MUTCD - Manual on Uniform Traffic Control Devices
NBS - National Bureau of Standards
NEC - National Electric Code
NEMA - National Electrical Manufacturer's Association
OSHA - Occupational Safety and Health Administration
SAE - Society of Automotive Engineers
SSPC - Steel Structures Painting Council
UL - Underwriters Laboratory
USASI - United States of America Standards Institute
WASHTO - Western Association of State Highway Transportation Officials

101.03 ACTUAL COST. The cost incurred by the Contractor in the performance of work. Actual cost includes labor, material, actual ownership cost of equipment determined from the owners records, or invoiced rental rates, and administrative overhead.

101.04 ADDENDUM. Contract revisions developed after advertisement and before opening proposals.

101.05 ADDITIONAL WORK. Additional work is an increase in the quantity of a contract item.

101.06 ADVERTISEMENT. The public announcement inviting proposals for the advertised work.

101.07 AWARD. The acceptance of a proposal by the Commission.

101.08 BASE. One or more layers of specified material placed on the subgrade to support the surface course.

101.09 BIDDER. Any individual or entity submitting a proposal for advertised work.

101.10 BID DOCUMENTATION. All writings, working papers, computer printouts, charts, and all other data compilation that contain or reflect information, data or calculations used by the Bidder to determine the bid proposal submitted, including but not limited to material relating to the determination and application of:

1. Equipment rates;
2. Overhead rates and related time schedules;
3. Labor rates;
4. Efficiency or productivity factors;
5. Arithmetic extensions;

6. Subcontractor and material supplier quotations;
7. Manuals standard to the industry used by the bidder in determining the proposal may be included by reference and will show the name and date of the publication and its publisher.

The term "Bid Documentation" does not include documents provided by the Department for use by the Bidder in the preparation of the bid proposal.

101.11 BOARD OF CONTRACT APPEALS. A board consisting of the Chief Engineer, the Operations Engineer, Chief Counsel and the Construction Engineer.

101.12 BRIDGE. A structure, including supports, erected over a depression or an obstruction, such as water, a highway, or a railway, and having a track or passageway for carrying traffic or other moving loads and a length measured along the center of roadway exceeding 20 feet (6.1 m) between under-copings of abutments or extreme ends of openings for multiple boxes.

The bridge length is the overall length measured along the line of survey stationing between backs of abutment backwalls or between ends of the bridge floor, but never less than the total clear opening of the structure.

The bridge roadway width is the clear width measured at right angles to the longitudinal centerline of the bridge between the bottom of curbs or guard timbers or, in the case of multiple heights of curbs, between the bottoms of the lower risers.

101.13 CALENDAR DATE OF COMPLETION. The fixed calendar date that all work on the project is to be complete.

101.14 CALENDAR DAY. Every day shown on the calendar beginning and ending at midnight.

101.15 CHANGE ORDER. A written order issued to the Contractor covering changes to the original Contract, and establishing the agreed-upon basis of payment and time adjustments for the work affected by the changes.

101.16 CHIEF ENGINEER. The Highways Engineering Division Administrator is designated "CHIEF ENGINEER" for the department who establishes engineering policy, resolves technical issues and resolves Contractor disputes.

101.17 THE COMMISSION. As provided by Section 2-15-2502 MCA, (as amended), the Transportation Commission is a quasi-judicial board assigned to the Department of Transportation for administrative support only.

101.18 CONFORMITY. Is compliance with:

A. Reasonable and customary manufacturing and construction tolerances where working tolerances are not specified or,
B. the specified working tolerances.

101.19 CONTRACT. The written agreement between the Commission and the Contractor detailing the obligations of the parties for the performance of the prescribed work.

The Contract includes the instruction to bidders; proposal; contract form; contract bond; specifications; general and detail plans; Detailed Drawings; Notice to Proceed; and all change orders, extra work orders, including authorized contract time extensions, that are required to complete the project.

101.20 CONTRACT BOND. The approved security on the Department's form, executed by the Contractor and its surety or sureties, guaranteeing the complete execution of the Contract and all supplemental agreements thereto and payment of all legal debts pertaining to the construction of the project.

101.21 CONTRACT ITEM (Pay Item). A specific unit of work for which a price is provided in the Contract.

101.22 CONTRACT TIME. The number of working days or the fixed calendar date allowed for completing the Contract, including authorized time extensions.

101.23 CONTRACTOR. The individual or legal entity contracting with the Commission to perform the prescribed work.

101.24 CULVERT. Any structure not classified as a bridge that provides an opening under the roadway.

101.25 DELAY. Any event, action, force, or factors that causes the contract work to extend beyond the specified Contract time.

- **A. Compensable Delay.** An excusable delay for which the Contractor may be entitled to additional compensation.
- **B. Excusable (noncompensable) Delay.** A delay to the contract or milestone/phase completion date that was beyond the Contractor's control and for which a contract or milestone time extension may be granted.
- **C. Non-excusable Delay.** A reasonably foreseeable delay to the contract completion date within the Contractor's control. No monetary compensation or time extension will be granted.

101.26 DEPARTMENT OF TRANSPORTATION. The State of Montana, Department of Transportation, acting through the Director and the Commission when the State is the awarding authority. Where Department is used alone, it means the Montana Department of Transportation. The Department's mailing address is: Montana Department of Transportation, 2701 Prospect Avenue, P.O. Box 201001, Helena, MT 59620-1001.

101.27 DETAILED DRAWINGS. An edition of special drawings, including necessary detailed instructions, that pertain to certain items of work contained in Department projects.

101.28 DIFFERING SITE CONDITIONS. Subsurface or latent physical conditions at the site that:

A. Differ materially from those indicated in the Contract; or
B. Differ materially from conditions normally encountered or, those conditions generally recognized as inherent in the nature of the work required in the contract; or
C. Unknown physical site conditions of an unusual nature. This does not refer to non-physical conditions (i.e., working relationships, etc).

101.29 THE DIRECTOR. The chief administrative officer of the Department, as established by law, and the Director's authorized agents.

101.30 THE ENGINEER. The District Engineer or District Administrator referred to as Engineer, acting directly or through an authorized representative (i.e., Project Manager), responsible for engineering and administrative supervision of the project.

101.31 EQUIPMENT. All machinery, tools, apparatus, and supplies necessary for the upkeep, maintenance, construction and completion of the project.

101.32 EQUITABLE ADJUSTMENT. An adjustment in the contract price or time.

101.33 EXTRA WORK. Work added to the original Contract required for the completion of the Contract.

101.34 EXTRA WORK ORDER. A written agreement amending the Contract that identifies work to be paid for at agreed prices or by force account under Subsection 109.04.

101.35 FORCE ACCOUNT WORK. A basis of payment to perform extra work when procedures of negotiation are unsuccessful. Force account work will be paid for under Subsection 109.04.2.

101.36 HOLIDAYS. Legal holidays are defined in the State of Montana laws (Section 1-1-216 MCA).

101.37 INSPECTOR. The Engineer's authorized representative assigned to make inspections of work and materials furnished.

101.38 INVITATION FOR BIDS. The advertisement for proposals for work or materials on which bids are requested. The advertisement goes out to interested parties to allow potential bidders an opportunity to examine the site, material sources, etc. It will indicate the estimated quantities and location of the work to be done or the character and quantity of the material to be furnished and the time and place of the opening of proposals.

101.39 LABORATORY. The Department testing laboratory or other testing laboratory designated by the Engineer.

101.40 MAJOR ITEM. Individual bid items having an original contract value equal to or exceeding 10 percent of the total original contract amount.

101.41 MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD). The F.H.W.A. "Manual on Uniform Traffic Control Devices" its current edition and its revisions. It includes the basic principles for the design and use of traffic control devices, but recognizes that engineering judgement is essential to the proper use of traffic control devices. The manual may be supplemented by Standard or Supplemental Specifications, Special Provisions, and by project circumstances when approved by the Engineer (See MUTCD, ¶2A-4).

101.42 MATERIALS. Substances specified for use in the construction of the project.

101.43 MEDIAN. The portion of a divided highway separating the traveled ways for traffic in opposite directions. Separation may be by open ground, raised median, or paint not including centerline stripping.

101.44 NOTICE TO PROCEED. Written notice to the Contractor to proceed with the contract work including the starting date of contract time.

101.45 PAVEMENT STRUCTURE. The combination of base course and surface course placed on a subgrade to support and distribute the traffic load to the roadbed.

101.46 PLANS. The approved contract drawings showing the location, type, dimensions, and details of the work required under the Contract.

101.47 PROFILE GRADE. The trace of a vertical plane intersecting the top surface of the proposed wearing surface, usually along the longitudinal centerline of the roadbed. Profile grade means either elevation or gradient of such trace according to the context.

101.48 PROJECT. The specific section of the highway or location on which construction is to be performed under the Contract.

101.49 PROPOSAL. A written offer by a bidder, on Department furnished forms, to perform the stated work at the quoted prices.

101.50 PROPOSAL FORM. The approved form on which bids must be prepared and submitted.

101.51 PROPOSAL GUARANTY. The security furnished with a proposal to guarantee that the bidder enters into the Contract if its proposal is accepted.

101.52 QUALITY CONTROL DEFINITIONS.

- **A.** Random Sampling - A selection procedure in which all potential samples have an equal chance of being selected for testing.
- **B.** Lot - A discrete quantity of material evaluated for acceptance.

C. Quality Control Plan - A detailed description of the type and frequency of inspection, sampling, and testing determined necessary to measure and control the various properties governed by Department specifications.
D. Acceptance Plan - A statistically based procedure for evaluating acceptance test results.
E. Price Reduction - A pre-established decrease in payment to the Contractor for a contract bid item in which the quality and workmanship, determined by statistical means, of a lot does not meet specifications.
F. Quality Incentive Allowance - A pre-established price increase in payment to the Contractor for a contract bid item in which a superior level of quality and workmanship, determined statistically, was performed.

101.53 RENTAL RATES. Hourly rates approved by the Department for furnishing and operating various types of construction equipment.

101.54 RESOURCES. The labor, equipment, and material necessary to perform work on a contract bid item or other element of work.

101.55 RESPONSIVE BID. A bid that meets all requirements of the Proposal and Instructions to Bidders.

101.56 RESPONSIBLE BIDDER. A bidder that the Department determines has the skill, ability and integrity to perform the project.

101.57 RIGHT-OF-WAY. Land, property, or interest, acquired for or devoted to a highway.

101.58 ROAD, HIGHWAY OR STREET. A public way for vehicular travel, including the entire area within the right-of-way.

101.59 ROADBED. The graded portion of a highway within the top and side slopes prepared as a foundation for the pavement structure and shoulders.

101.60 ROADSIDE. The areas between the outside edges of the shoulders and the right-of-way boundaries and other areas within the right of way not intended for motorized travel.

101.61 ROADSIDE DEVELOPMENT. Those items necessary for:
A. The preservation of landscape materials and features;
B. The rehabilitation and protection against erosion of areas disturbed by construction through seeding, sodding, mulching, and the placing of other ground covers; and suitable plantings; and
C. Other improvements that increase the effectiveness and enhance the appearance of the highway.

101.62 ROADWAY. The portion of a highway within the limits of construction.

101.63 SHOULDER. The portion of the roadway adjacent to the traveled way for accommodation of stopped vehicles for emergency use and for lateral support of base and surface courses.

101.64 SIDEWALK. That portion of the right of way constructed for pedestrian use.

101.65 SPECIAL PROVISIONS. Modifications to the Standard and Supplemental Specifications applicable to an individual project.

101.66 SPECIFICATIONS. The compilation of provisions in this book; the Supplemental Specifications and Special Provisions for the performance of the project.

101.67 STATE. The State of Montana acting through its authorized representative.

101.68 STRUCTURES. Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, endwalls, buildings, sewers, service pipes, underdrains, foundation drains, and other features that may be encountered in the work.

101.69 SUBCONTRACTOR. An individual or legal entity to which a Contractor sublets part of the work.

101.70 SUBGRADE. The top surface of a roadbed upon which the pavement structure, shoulders, and curbs are constructed.

101.71 SUBSTRUCTURE. All of the structure below the bearings of simple and continuous spans, skewbacks of arches, and tops of footings of rigid frames, together with the backwalls, wingwalls, and wing protection railings.

101.72 SUPERINTENDENT. The Contractor's authorized representative in responsible charge of the work.

101.73 SUPERSTRUCTURE. The entire structure except the substructure as defined in Subsection 101.71.

101.74 SUPPLEMENTAL SPECIFICATIONS. Approved additions and revisions to the standard specifications.

101.75 SURETY. The legal entity or individual, other than the Contractor, executing a bond furnished by the Contractor (see §28-11-401, MCA).

101.76 SURFACE COURSE. One or more layers of a pavement structure designed to accommodate the traffic load, the top layer of which resists skidding, traffic abrasion, and the disintegrating effects of climate. The top layer is sometimes called the "wearing course."

101.77 TITLES (OR HEADINGS). The titles or headings of the divisions, sections, and subsections are for convenience of reference and do not have any bearing on their interpretation.

101.78 TOPSOIL. Topsoil under Section 203 is soil that supports normal plant growth.

Topsoil under Section 610 is soil that supports normal plant growth and meets Subsection 713.05 requirements.

101.79 TRAVELED WAY OR PRESENT TRAVELED WAY. The existing paved or graveled roadway section in use including the shoulders and auxiliary lanes.

101.80 UNBALANCED BIDS.

A. **Materially Unbalanced.** A bid that generates a reasonable doubt that award to the bidder submitting a mathematically unbalanced bid will result in the lowest ultimate cost to the Department.

B. **Mathematically Unbalanced.** A bid containing lump sum or unit bid items that do not reflect reasonable actual costs plus a reasonable proportionate share of the bidder's anticipated profit, overhead costs, and other indirect costs.

101.81 WORK. The furnishing of all resources necessary to complete the project.

101.82 WORKING DAY. All days are considered working days except Saturdays, Sundays, holidays, days on which the Contractor is specifically required by the Contract to suspend construction operations, and all days during the period of November 16 through April 15.

101.83 WORKING DRAWINGS. Stress sheets, shop drawings, erection plans, falsework plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel, or other supplementary plans or similar data that the Contractor is required to submit to the Project Manager.

SECTION 102
BIDDING REQUIREMENTS AND CONDITIONS

102.01 JOINT-VENTURE BIDS. Execute a "Declaration of Joint Venture and Power of Attorney" form available from the Department's Contract Plans Section to submit bid packages for highway construction as a joint venture. Designate the business name of the joint venture and specifically authorize a person to execute all bid packages and contracts with the Commission on behalf of all individuals and legal entities of the joint venture. Authorize this person to receive all monies due under the Contract and issue binding receipts and releases with the Department. File joint-venture affidavits with the Department's Contract Plans Section in Helena not later than 3:00 p.m. the workday preceding the date of the bid letting.

Joint venture firms do not need to separately incorporate.

102.02 CONTENTS OF BID PACKAGE. The bid package ordinarily includes the following:

- **A.** Transmittal Sheet.
- **B.** Instructions To Bidders.
- **C.** Disadvantaged Business Enterprise (DBE) Requirements.
- **D.** Equal Opportunity Clause Certification.
- **E.** Estimated Quantity Sheets.
- **F.** Contract Proposal.
- **G.** Acknowledgment Of Receipt Of Addendum.
- **H.** Special Provisions.
- **I.** Supplemental Specifications.
- **J.** Wage Rate Schedules.
- **K.** Contract Plans.
- **L.** Other documents included by reference but not attached.
- **M.** FHWA Form 1273 - Required Contract Provisions for Federal-Aid Construction Contracts when applicable.

Documents submitted with or attached to the proposal form are a part of the bid. Do not detach or alter attached documents when the bid package is submitted.

102.03 VACANT.

102.04 ISSUANCE OF PROPOSALS. The Department reserves the right to refuse to issue a proposal form to a bidder for any of the following reasons:

- **A.** Uncompleted work that the Department determines might hinder or prevent the prompt completion of additional work;
- **B.** Default under previous contracts;

C. Failure to reimburse the Department for overpayment's made on any contract or contracts after written notification of the overpayment's that are due;
D. Failure to pay, or satisfactorily settle, all bills due for labor and material on any Contract in force at the time of issuance of proposals;
E. Unsatisfactory performance on previous or current Contract(s);
F. Misconduct that is of such a serious nature as to adversely affect the Contractor's ability to perform future work;

Request bid package and instructions to bidders from the Department.

Pay the Department the sum stated in the Invitation for Bids for each copy of the bid package and set of full size plans requested.

102.05 QUANTITIES OF WORK IN THE BID PROPOSAL. Submit unit bid prices for the estimated quantities.

Estimated quantities may be increased or decreased under the Contract.

Payment will be made for the actual quantities of work performed and accepted or materials furnished under the Contract.

102.06 EXAMINATION OF DOCUMENTS AND SITE OF WORK. Examine the site of the proposed work including existing field staking and documents before submitting a bid proposal. Submitting a bid proposal is an affirmative statement by the bidder that the bidder has examined the site and is satisfied with the conditions to be encountered in performing the work and the requirements of the bid package.

The Department is not bound by any statement or representation concerning conditions or description of the work unless included in the bid package. Do not rely on oral explanations or instructions given by Department employees or agents before award of the Contract. Accept these as non-binding oral explanations or instructions and relying on them is solely at the Bidder's risk.

Immediately submit any request for an explanation of the meaning or interpretation of the bid package in writing to the Engineer.

The records of any subsurface investigations conducted by the Department are available for inspection as a public document. Inspect available records at the Materials Bureau or Bridge Bureau in Helena or the District where the project is located.

The records of subsurface investigations are not a part of the bid package or contract, but are available to all bidders for informational purposes only. There is no warranty or guaranty, either expressed or implied, that the subsurface investigation records will disclose the actual conditions that will be encountered during the performance of the work. Department subsurface investigation results may differ from a bidders independent subsurface investigation due to different sampling techniques, the date of the investigation, etc.. Using or relying on Department subsurface investigations is at the bidder's risk. The Bidder must perform and rely on its independent subsurface investigations made before submitting a bid proposal. Submittal of a bid is an affirmative statement that a independent subsurface investigation was made and Department subsurface investigations were not relied on.

Individual test boring log data included in the Department's subsurface investigation records apply only to that particular boring taken on the date indicated.

The character of any material or conditions between or around test borings on the date of the site examination are not conclusive.

Submission of a bid waives any potential claim of the above, including a claim of justifiable reliance on such information or materials.

Bidders must not take advantage of an apparent error, omission or ambiguity in any part of the bid package. Upon discovery, immediately notify the Engineer in writing if an error, omission, or ambiguity exists and why it appears erroneous, omitted, or ambiguous. Advise bidders submitting a subcontract quotation of this obligation and clarify their responsibility to include this information with their subcontract quotation. The Department will clarify the error, omission, or ambiguity and, if necessary and possible, issue an addendum to all prospective bidders before opening bid packages.

Do not submit a bid proposal or a subcontract quote without receiving clarification. Failure to provide written notification is a waiver of the error, omission or ambiguity, and additional compensation or contract time will not be allowed.

102.07 PREPARATION OF PROPOSAL. The bid proposal must be submitted on Department furnished forms.

Include a unit and total item price in clearly legible figures for each estimated item of work shown. Obtain the item's total item price by multiplying the unit price by the estimated quantity.

Include a total price in clearly legible figures for lump sum items.

The unit price prevails if a discrepancy exists between the item's unit price and the item's total price. The item total price prevails if the unit price is ambiguous, illegible, unintelligible, or uncertain for any reason, or is omitted, or is the same amount as the item total price. The unit price will then be established by dividing the total item price by the item estimated quantity.

Indicate the choice selected when an item in the bid package permits a choice to be made according to the requirements for the item. The choice made is final and no further choice is permitted.

Submit bids on all alternates when the bid package contains alternates for various items. Contract award will be made on the alternate selected by the Commission.

Submittal of a bid package is evidence that sufficient time was available to:

A. Adequately prepare a bid proposal;

B. Conduct a complete investigation of the site of work and all Contract documents.

102.08 REJECTION OF BID PROPOSALS. The Commission reserves the right to reject bid proposals, waive technicalities, or advertise for new proposals.

A bid proposal is irregular and will be rejected as non-responsive if:

A. Bidder fails to properly sign the bid proposal;

B. There are unauthorized additions, conditional or alternate bids, or irregularities that make the bid package incomplete, indefinite, or ambiguous;

C. The proposals for two or more projects advertised separately are connected or made contingent one upon the other so that the proposal for one project

carries a provisional deduction in the bid price on one or more of the other projects;

D. Any unauthorized provisions are added reserving the right to accept or reject an award or to enter into a contract pursuant to an award;

E. More than one proposal for the same work from an individual, firm, corporation, partnership, or joint venture under the same or different name is submitted;

F. Evidence of collusion among bidders exists. Participants in collusion will not receive recognition as bidders, either singly or as a joint venture, for future work of the Department until re-instated as qualified bidders;

G. A bidder is a participant in more than one proposal for the work contemplated. The Commission will reject all proposals in which the bidder is a participant;

H. Bidder fails to furnish a signed proposal guaranty in the amount stipulated on the bid proposal form.

A bid proposal is considered irregular and may be rejected as non-responsive if:

A. The Department furnished bid proposal is not used or is altered;

B. Bidder fails to include a name and mailing address;

C. The unit prices contained in the proposal are obviously unbalanced, either in excess of or below the reasonable cost-analysis value;

D. The proposal figures are not typed or completed in ink or are not legible;

E. The proposal does not contain a unit and total price for each estimate pay item, except for authorized alternate bid items;

F. There are changes in the proposal such as erasures, strikeouts, and white-outs that are not initialed in ink;

G. Non-compliance with Disadvantaged Business Enterprise (DBE) requirements.

102.09 PROPOSAL GUARANTY. Make the proposal guaranty unconditionally payable to the Department. Provide the guaranty by cash, cashier's check, certified check, bank money order, or bank draft with the bid proposal. The guaranty must be drawn and issued by a national banking association located in Montana or by any banking corporation incorporated under the laws of the State, or a bid bond or bonds executed by a surety corporation authorized to do business in the State.

102.10 DELIVERY AND PUBLIC OPENING OF PROPOSALS. Place the bid proposal in a sealed envelope plainly marked to indicate the contents. Mail or deliver to: Montana Department of Transportation, 2701 Prospect Avenue, P.O. Box 201001, Helena, Montana 59620-1001.

Bid proposals will be opened and read publicly at the place, time, and date specified in the " Invitation for Bids".

Deliver by the date and hour set for the opening of bid proposals to the Department officials conducting the bid opening. Bid proposals received after the specified time are returned to the bidder unopened.

The bid opening time is determined by the clock designated by the Department bid opening officials.

Mailed proposals must be received by the Department's official conducting the bid opening before the bid opening time. The Contractor is solely responsible for the proposal's delivery.

Do not submit bid proposals by facsimile machines.

A prematurely opened bid proposal not properly addressed and identified will be returned to the bidder.

102.11 WITHDRAWAL OR REVISION OF PROPOSALS. Submit withdrawal requests to the Department in writing or telegram before the time set for opening bid proposals. A bidder may withdraw any proposal in person or through an authorized agent before any bid proposal on that project is opened.

Submit written revisions to the Department before the time set for opening of bid proposals as provided for in Subsection 102.10.

102.12 VACANT.

102.13 MATERIALS GUARANTY. The successful bidder may be required to furnish a complete statement of the origin, composition, and manufacture of materials to be used in the construction of the work, together with samples to be tested for conformance with the Contract requirements. The costs of furnishing the statements and samples is to be included in the bid.

102.14 VACANT.

102.15 VENUE. In the event of any dispute concerning a project, whether over its advertisement, bidding, award, execution, or claim, any litigation filed by or against the Department will only have venue in Lewis and Clark County.

102.16 CONSENT TO CONTRACT PROVISIONS. The submission of a bid is an affirmative statement that the bidder consents to all the bid package provisions upon which it has submitted its bid. That consent extends to all portions of the bid package and applies to all the bidder's subcontractors. Do not submit a bid proposal unless consent to all the bid package provisions is given.

SECTION 103
AWARD AND EXECUTION OF CONTRACT

103.01 CONSIDERATION OF PROPOSALS. Bid proposals will be compared on the basis of the summation of the item total prices shown in the bid schedule.

103.02 AWARD OF CONTRACT. The Contract will be awarded within 45 calendar days after the bid opening to the lowest responsive, responsible, and qualified bidder whose bid proposal complies with all the requirements. The successful bidder will be notified in writing of the acceptance of the proposal and the award of the Contract.

If the Contract is not awarded within 45 calendar days, all bid proposals will be rejected and the proposal guaranties returned. The Commission can extend the 45 day time period.

103.03 ASSIGNMENT OF CLAIMS. In consideration of being awarded the Contract, the Contractor, on its own behalf and on behalf of its subcontractors, assigns to the Department all claims or causes of action for any antitrust law violations, or damages arising therefrom, as to goods, materials, and services purchased under the terms of the Contract or any change order that may result from the Contract.

103.04 CANCELLATION OF AWARD. The award of the Contract may be canceled at any time before the execution of the Contract by all parties without liability against the Department.

103.05 RETURN OF PROPOSAL GUARANTY. Except for the three lowest bidders, all proposal guaranties other than bid bonds will be returned immediately following opening and checking of the proposals. The retained proposal guaranties of the unsuccessful two lowest bidders will be returned within 10 calendar days following the award of the Contract. The successful bidder's proposal guaranty will be returned after a satisfactory contract bond has been furnished and the Contract has been executed.

103.06 CONTRACT BOND. Furnish an executed contract bond or bonds in a sum equal to the Contract amount under Subsection 103.07. Use a form provided by the Department and executed by a surety company authorized by law to transact business in the State.

103.07 EXECUTION AND APPROVAL OF CONTRACT. Return to the Department within 20 calendar days after receipt of the contract documents:

A. The signed Contract;
B. The contract bond;
C. A copy of the insurance policy or a certificate of insurance;
D. A copy of a current special fuel users permit issued under 15-70-302 MCA.

A proposal will not be binding unless all the above requirements have been satisfied.

Do not begin work before:

A. The Contract is executed;
B. Contract bond is completed;
C. Evidence of the required insurance is provided.

The Contract, bond, and insurance are subject to legal approval after execution by the Contractor and Surety.

103.08 FAILURE TO EXECUTE CONTRACT. Upon failure to execute the Contract and file acceptable bonds and insurance policies within 20 calendar days after receipt of the Contract the award may be canceled and the proposal guaranty forfeited under the provisions of Section 18-1-204, MCA. Award may then be made to the next lowest responsive, responsible and qualified bidder, or the work may be re-advertised.

SECTION 104
SCOPE OF WORK

104.01 INTENT OF CONTRACT. Furnish all resources required to complete the work under the Contract.

104.02 DIFFERING SITE CONDITIONS, SUSPENSIONS OF WORK, AND SIGNIFICANT CHANGES IN THE CHARACTER OF WORK.

104.02.1 Differing Site Conditions. During the progress of the work, if subsurface or latent physical conditions are encountered at the site differing materially from those indicated in the Contract or if unknown physical conditions of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the work provided for in the Contract, are encountered at the site, the party discovering such conditions shall promptly notify the other party in writing of the specific differing conditions before they are disturbed and before the affected work is performed.

Upon written notification, the Engineer will investigate the conditions. If the Engineer determines that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any work under the Contract, an adjustment, excluding loss of anticipated profits, will be made and the Contract modified in writing accordingly. The Engineer will notify the Contractor of the determination whether or not an adjustment of the Contract is warranted.

No contract adjustment which results in a benefit to the Contractor will be allowed unless the Contractor has provided the required written notice.

No Contract adjustment will be allowed under this clause for any effects caused on unchanged work.

104.02.2 Suspensions of Work Ordered By the Engineer. If the performance of all or any portion of the work is suspended or delayed by the Engineer in writing for an unreasonable period of time (not originally anticipated, customary, or inherent to the construction industry) and the Contractor believes that additional compensation and/or contract time is due as a result of such suspension or delay, the Contractor shall submit to the Project Manager in writing a request for adjustment within seven calendar days of receipt of the notice to resume work. The request shall set forth the reasons and support for such adjustment.

Upon receipt, the Engineer will evaluate the Contractor's request. If the Engineer agrees that the cost and/or time required for the performance of the Contract has increased as a result of such suspension and the suspension was caused by conditions beyond the control of and not the fault of the Contractor, its suppliers, or subcontractors at any approved tier, and not caused by weather, the Engineer will make an adjustment (excluding profit) and modify the Contract in writing accordingly. The Contractor will be notified of the Engineer's determination as to whether or not an adjustment of the Contract is warranted.

No contract adjustment will be allowed unless the Contractor has submitted the request for adjustment within the time prescribed.

No contract adjustment will be allowed under this clause to the extent that performance would have been suspended or delayed by any other cause, or for

which an adjustment is provided for or excluded under any other term or condition of the Contract.

104.02.3 Significant Changes in the Character of Work. The Engineer reserves the right to make, in writing, at any time during the work, such changes in quantities and such alterations in the work as are necessary to satisfactorily complete the project. Such changes in quantities and alterations shall not invalidate the Contract nor release the surety, and the Contractor agrees to perform the work as altered.

If the alterations or changes in quantities significantly change the character of the work under the Contract, whether such alterations or changes are in themselves significant changes to the character of the work or by affecting other work cause such other work to become significantly different in character, an adjustment, excluding anticipated profit, will be made to the Contract. The basis for the adjustment shall be agreed upon before the work is performed. If a basis cannot be agreed upon, then an adjustment will be made either for or against the Contractor in such amount as the Engineer may determine to be fair and equitable.

If the alterations or changes in quantities do not significantly change the character of the work to be performed under the Contract, the altered work will be paid for as provided elsewhere in the Contract.

The term "significant change" shall be construed to apply only to the following circumstances:

1. When the character of the work as altered differs materially in kind or nature from that involved or included in the original proposed construction; or
2. When a major item of work, as defined in Subsection 101.40, is increased in excess of 125 % or decreased below 75% of the original contract quantity. Any allowance for an increase in quantity shall apply only to that portion in excess of 125% of original contract item quantity, or in case of a decrease below 75%, to the actual amount of work performed.

104.02.4 Change Orders. Change orders will include the following information:

1. A description of the altered, increased, or decreased work or description of other change necessitating the change order;
2. An estimate of the types and quantities of work to be performed and a listing of the agreed prices and contract unit prices at which payment will be made;
3. Contract time adjustments.

Change orders must be executed by both parties to the Contract and become a part of the Contract.

Payment for the work will be made for the actual quantities of work performed at the prices specified in the change order.

104.03 EXTRA WORK. Perform unanticipated work, not included in the Contract, if determined necessary to complete the project. Perform extra work as directed. Payment for extra work is made under Subsection 109.04.

Extra work performed without an executed written order will not be paid for.

104.04 MISCELLANEOUS WORK. This is any minor work or material that is necessary to the work.

Miscellaneous work, as provided for in the Contract, is measured by the respective unit for either the material or work performed as directed in writing by the Project Manager.

Payment for miscellaneous minor work is at agreed prices or on a force account basis.

104.05 MAINTENANCE OF THE WORK.

104.05.1 General. Perform maintenance work on completed and uncompleted parts of the project until acceptance under Subsection 105.15.

Maintenance includes, but is not limited to the following:

1. Patching chuck holes with asphalt mix;
2. Reshaping the subgrade, side slopes, ditch sections, or aggregate courses, as necessary;
3. Cleaning debris from drainage courses, culverts, and inlets;
4. Removing rocks or earth from the roadway and ditch sections;
5. Removing debris resulting from construction activities;
6. Providing access to residences, businesses, and roads and keeping the present accesses open;
7. Repair or replace minor damaged parts of the work;
8. Repair or replace extensive damage, not by Contractor negligence, under Subsection 104.02.4;
9. Maintenance of the constructed roadway under Subsection 203.03.5;
10. Disposing of removed matter;
11. Maintenance of irrigation water under Subsection 104.05.6;
12. Other maintenance-type work not specifically described but necessary for the maintenance and protection of traffic or of completed and uncompleted portions of the project.

Maintenance work performed before acceptance under Subsection 105.15 is incidental to other Contract items.

104.05.2 Failure To Properly Maintain Roadway or Structure. The Project Manager will immediately notify the Contractor if it fails to maintain the project. Failure to remedy unsatisfactory maintenance within 24 hours after receipt of the notice will cause the Department to take over project maintenance. The cost of the maintenance will be deducted from monies due or to become due the Contractor, or otherwise be billed to the Contractor.

104.05.3 Maintenance for Traffic and Detours.

A. **Maintenance for Traffic.** Keep the road open to traffic during the work or provide detour roads as specified or directed.

Maintain the work under construction to accommodate traffic. Construct and maintain all accesses to parking lots, garages, businesses, residences, farms, etc. The cost of this work is incidental to other items of the Contract.

Provide traffic control meeting the approved traffic control plan, Section 618 - Traffic Control, and the MUTCD.

B. **Special Detours.** When the Contract has the item Detour - Construct, Maintain, and Remove, it includes constructing and maintaining the detour,

including constructing and removing temporary bridges, pipes and associated work and obliterating the detour road.

Do not use all or any portion of an existing structure, as defined in Subsection 101.68, without the Engineer's approval. Do not modify existing structures or construct temporary structures without Department approval before starting work. This work is incidental to the contract item.

The Department will provide the right-of-way for temporary detours or bridges specified in the Contract.

104.05.4 Maintenance for Traffic During Work Suspensions.

A. **Temporary Suspension.** Make passable and open to traffic portions of the project, connections, and temporary roadways before temporary work suspensions. Maintain parts of the project, connections, temporary roadways, and detours under traffic at Contractor expense during work suspensions.

B. **Winter Suspension.** Before winter weather work suspension, including the time between November 16 through April 15, make a written request for an inspection of the project or portions of the project to remain open to traffic. Correct all areas not acceptable to the Engineer and district maintenance representative as directed. Construct all portions of the project that remain open to traffic, including temporary roadways, to provide drainage and snow storage and place in a safe, smooth driving condition. Provide roadway widths that permit the safe use of snow-removal equipment.

1. **Snow Removal.** Snow removal is by and at the Department or County expense. Remove snow for construction or areas not used by the traveling public at Contractor expense.
2. **Other Maintenance Functions.** The Department will perform routine maintenance functions on all portions of the project not affected by the Contractor's operations. Maintain portions of the project affected by construction operations.

   Failure to maintain the project under these requirements will invoke Subsection 104.05.2.

   Resume maintenance for the entire project once work resumes.

   Replace or repair all work or materials lost or damaged due to temporary use of the project. Maintenance required for events that are outside the Contractor's control during work suspensions are paid for at contract unit prices or as extra work.

104.05.5 Maintenance of Traffic Control Devices During Seasonal Work Suspensions. Furnish and install all required traffic control devices on all portions of the project and temporary roadways to be left open to traffic before seasonal shutdown. The Department will maintain traffic control devices during seasonal shutdowns.

Resume maintenance responsibility for traffic control devices on the project once the resume work order is issued.

104.05.6 Maintenance of Irrigation Water. Construct or move irrigation structures, boxes, channel changes, and culverts to maintain irrigation water flow at Contractor expense.

Do not shut off irrigation water in an irrigation ditch without the water-master or ditch owners written permission.

104.06 RIGHTS IN AND USE OF MATERIALS FOUND ON THE WORK. Obtain the Engineer's approval to use excavated materials found in other parts of the work. The quantity of excavated material used will be paid for under the pay item for which the material is used. Payment will not be made under any other pay item for excavating the material. Replace the removed material with acceptable material at Contractor expense.

Do not excavate or remove material from within the right-of-way that is outside the grading limits without written permission.

104.07 FINAL CLEANING UP. Clean the highway, borrow pits, and all ground used in performance of the work of all rubbish, debris, excess materials, temporary structures, and equipment before final acceptance.

Meet the requirements of Subsection 106.02.5 for final cleanup of borrow and aggregate sources.

The final cleanup work of the project area and the pits, borrow areas, or quarries is not paid for directly but is incidental to other Contract items.

Specify the conditions for final cleanup in all landowner agreements. Complete all cleanup conditions before final project acceptance.

104.08 VALUE ENGINEERING PROPOSALS. Cost savings generated on the Contract from cost reduction proposals offered by the Contractor and approved by the Department will be shared.

The Contractor is encouraged to submit proposals for modifying the contract that reduces the total cost of construction. The cost reduction proposal must not impair the essential functions or characteristics of the project including but not limited to service life, economy of operation, ease of maintenance, reliability, desired appearance, and safety.

Submit the proposal in writing and include the following information:

1. A description of both the existing work and proposed changes for performing the work with a discussion of the comparative advantages and disadvantages;
2. An itemization of the necessary changes to the contract if the proposal is accepted;
3. A detailed cost estimate for performing the work under the existing contract and under the proposed change detailing quantities and dollar amounts for each work item;
4. An estimate of the effect the proposed changes would have on other costs to the Department;
5. A time frame within which the Department must make a decision;
6. The dates, project numbers and the action of the Department if the proposal was previously submitted;

7. A statement of the effect implementation of the proposal would have on the contract completion time.

The Department is not required to consider a proposal or be liable to the Contractor for failure to accept or act on a proposal submitted under this specification including delays to the work attributable to the proposal. Proposals that are similar to a change in the contract that are under consideration or have been adopted by the Department before the submittal will not be accepted. The Department reserves the right to make these changes without compensation to the Contractor.

Continue to perform the work according to the contract requirements until the Department has taken final action on the proposal. Consider the proposal rejected if the Department's final decision is not received within the time frame specified in the Contractor's submittal.

The Department will determine the acceptability and the estimated net savings in construction costs from the adoption of all or part of a proposal. The Department will disregard the contract bid prices if these prices do not represent a fair measure of the value of work to be performed or to be deleted. The Department's costs for reviewing and implementing proposals including any increased costs to the Department resulting from its application, will be deducted from the total estimated cost saving to arrive at the net savings.

The Department's cost of investigating a proposal will be at the Contractor's expense with the submittal of a proposal constituting the Department's authority to deduct these costs from any monies due or that may become due to the Contractor under the Contract.

Proposals accepted by the Department in whole or in part will be by a change order. The change order will incorporate the changes in the contract necessary to implement the proposal and will include any conditions placed on the approval by the Department. The change order will establish the estimated net savings in the cost of performing the work attributable to the proposal and provide for payment of 50% of the estimated net savings to the Contractor.

Acceptance of proposals does not extend the contract time unless specifically provided for in the change order.

The payment amount specified in the change order constitutes full compensation to the Contractor for the proposal and the performance of the work.

The Department reserves the right to apply a proposal for general use on other contracts administered by the Department. When an accepted proposal is applied for general use, only the Contractor who submitted the initial proposal is eligible for compensation and this compensation applies only to those contracts awarded to the Contractor before submission of the accepted proposal. Proposals that are identical or similar to previously submitted proposals will be eligible for consideration and compensation under this specification if the proposals were not previously adopted for use in other contracts administered by the Department. Subject to these provisions, the Department reserves the right to use all or any part of any submitted proposal without obligation or compensation to the Contractor.

This specification applies only to the Contractor awarded the contract.

No consideration will be given to, and no payment made for any claims for additional compensation for changed conditions that are attributable to the approved proposal.

SECTION 105
CONTROL OF WORK

105.01 AUTHORITY OF THE ENGINEER. The Engineer will decide all questions regarding the quality and acceptability of materials furnished, work performed, the rate of progress of the work, the interpretation of the Contract; and the acceptable fulfillment of the Contract.

A. The Engineer will suspend the work wholly or in part for failure to:
   1. Correct conditions unsafe for project personnel or the public; or
   2. Carry out provisions of the Contract; or
   3. Carry out orders of the Engineer.

B. Work may also be partially or wholly suspended for:
   1. Periods necessary due to unsuitable weather; or
   2. Conditions unsuitable for the prosecution of the work; or
   3. Any condition or reason determined to be in the Department's interest.

105.02 PLANS AND WORKING DRAWINGS. The plans show the details of structures, lines, grades, typical roadway cross sections, location and design of structures, and a summary of items appearing in the bid package.

Supplement the plans with Contractor prepared working drawings to adequately control the work. Provide detail working drawings for structures to control the work that are not included in the department furnished plans. Working drawings include stress sheets, shop drawings, erection plans, falsework plans, cofferdam plans, bending diagrams for reinforcing steel, computations, or other supplementary plans or similar data required of the Contractor. Check and approve working drawings before submittal to the Project Manager. The Contractor's approval must be shown on the drawings.

Assure working drawings, falsework plans, and calculations for facilities open to public travel are signed by a professional engineer before submittal to the Project Manager.

105.03 CONFORMITY WITH PLANS AND SPECIFICATIONS.

105.03.1 General. Perform work and furnish materials to meet the Contract requirements.

Provide materials and workmanship uniform in character and meeting the plan dimensions and contract specifications.

When a contract item does not meet the contract requirements but is adequate to serve the design purpose, the Engineer will determine the extent the work will be accepted and remain in place. The Engineer will document the basis of acceptance by change order, providing an adjustment in the contract unit price.

When a contract item does not meet the Contract requirements resulting in work inadequate to serve the design purpose, remove and replace or correct the work by and at Contractor expense.

105.03.2 Items Designated for Acceptance on A Lot Basis. Contract items listed in Table 105-1 are designated for acceptance on a lot-by-lot basis. The elements in the table will be evaluated and the contract items accepted under this provision. All

other contract items will be evaluated for acceptance under the applicable specifications covering those items.

An element of a lot will be evaluated for conformance when results of one or more tests are outside specified tolerance limits for that element.

All the individual test results in the lot for the element to be evaluated will be averaged, and the percent of price reduction for the lot determined by the applicable formula.

1. The formula **P = (Xn + aR - Tu) x F** will be used if a maximum limit only is specified; or when the average of the test values is above the midpoint of a specified band or above a job mix target value.

2. The formula **P = (TL + aR - Xn) x F** will be used if a minimum limit only is specified; or when the average of the several test values is below the midpoint of a specified band or below a job mix target value.

TABLE 105-1
CONTRACT ITEMS - EVALUATION ELEMENTS

	ELEMENTS EVALUATED					
ITEM	**Aggregate Gradation**	**Fineness Modulus**	**Penetration**	**Compaction**	**Cleanness Value**	**Fracture**
Selected Surf	X					
Sand Surf	X					
Cr Base Crse Type A	X					X
Cr Base Crse Type B	X					
Cr Top Surf Type A	X					X
Cr Top Surf Type B	X					
Cr Agg - Cover Mat.	X				X	X
Portland Cement-Treated Base	X					
PM Surf and Base	X			X		X
OGFC	X					X
AC used in PM Surf, Base and OGFC			X			
PCCP	X	X				

Where:

P is the percent of reduction in contract price.

Xn is the average of the several test values from samples taken from the lot, with **n** indicating the number of values.

a is a variable factor to be used as **n** changes according to the following: when n is 3, a = 0.45; n is 4, a = 0.38; n is 5, a = 0.33; n is 6, a = 0.30; and n is 7, a = 0.28.
R is the difference between the highest and lowest values in the group of several test results from the lot.
Tu is the upper or maximum tolerance limit permitted by the specifications.
TL is the lower or minimum tolerance limit permitted by the specifications.
F is the price reduction factor to be applied for each element as shown in Table 105-2.

TABLE 105-2
TABLE OF PRICE REDUCTION FACTORS

ELEMENT	FACTOR "F"
100% size sieve	1
½-inch (12.5 mm) sieve and larger	1
No. 100 (0.150 mm) sieve to 3/8-inch (9.5 mm) sieve inclusive (except 100% size sieve)	Cover Material, 2 All Other Aggregates, 3
No. 200 (0.075 mm) sieve	Cover Material, 3 All Other Aggregates, 7
Fine aggregate fineness modulus	12
O.G.F.C. No. 4 (4.75 mm) sieve	4
O.G.F.C. No. 8 (2.35 mm) sieve	5
O.G.F.C. No. 200 (0.075 mm) sieve	6
Penetration 85-100 Asphalt Cement	3
Penetration 120-150 Asphalt Cement	2
Penetration 200-300 Asphalt Cement	1
Compaction	12
Fracture	2

If **P** is less than 3 or a negative quantity, the lot will be accepted as being in conformance. If one or more elements for a contract item show a positive **P** value, the positive values will be added and the resulting sum used to determine whether the lot is in conformance. If the total **P** value is between 3 and 25, the Engineer may require correction or accept the lot at a reduced price. If **P** is greater than 25, the Engineer may: **(1)** require complete removal and replacement with specification material at Contractor expense; **(2)** require corrective action to bring the material into conformance at Contractor expense; or, **(3)** where the finished product is found to be capable of initially performing the intended purpose but with a reduced service

life expectancy, permit leaving the material in place with an appropriate price adjustment calculated using a **P** value ranging between 25 and 50.

Immediately halt production following written notification when either of the following has occurred:

1. Three consecutive lots for a contract item have an individual total **P** value of 5 or more;
2. Beginning with the second lot, when three tests within one lot have one or more elements outside the specification bands and the total **P** value for the lot is 5 or more.

Make adjustments to bring the product within the specification limits before resuming production. The Contractor does not have the option of accepting a price reduction in lieu of producing specification material. Continued production of non-specification material is prohibited. Material that is obviously defective may be isolated and rejected without regard to sampling sequence or location within a lot.

105.03.3 Quality Incentive Allowance. A pay factor of 1.05 will be applied to the plant mix surfacing lots where the results of aggregate gradation tests for the No. 4, No. 40, and No. 200 sieves are not more than one-half the allowable tolerance from the job mix target value. A pay factor of 1.05 will be applied to the lots of plant mix surfacing where the average density for the lot **(Xn)** is from 97 percent to 98 percent, inclusive, of the target field Marshall density and the range **(R)** is three or less.

Quality incentive allowances will be used to offset any price reductions on progress estimates. Any quality incentive allowance remaining after all price reductions have been deducted will be paid as a lump sum when all work on the item is complete.

105.04 COORDINATION OF CONTRACT PROVISIONS. All documents referred to in Subsection 101.19 are essential parts of the Contract, and a requirement occurring in one is binding as though occurring in all. They are complementary and describe and provide for a complete contract. If a discrepancy exists, the governing ranking will be:

Dimensions	**Information**
1. Plan	1. Special Provisions
2. Calculated	2. Plans
3. Scaled	3. Supplemental Specifications
	4. Standard Specifications
	5. Detailed Drawings

105.05 COOPERATION BY CONTRACTOR. The Engineer will supply a minimum of 15 sets of contract documents. Keep at least one set available on the project at all times.

Give the work the constant attention necessary to facilitate progress and cooperate with the Engineer, Project Manager, the inspectors, and other contractors.

Maintain a competent Superintendent capable of reading and understanding the Contract documents who is experienced in the work being performed at all times.

Provide the Project Manager in writing the Superintendent's name assigned to the project, before work starts.

The Superintendent will receive instructions from the Project Manager or authorized representatives. The Superintendent shall have authority to execute written orders or directions of the Project Manager without delay and promptly supply the resources to complete the Contract.

105.06 COOPERATION WITH UTILITIES. The Department will require utility companies, pipeline owners, and other utility agencies to adjust the utility fixtures, pipelines, and other appurtenances within or adjacent to the construction limits.

Cooperate with utility owners in the removal and rearrangement of utility facilities to minimize interruption to utility service and duplication of work by the utility owner.

All utility facilities within the construction limits will be relocated or adjusted by the owners.

Submission of a bid is an affirmative statement that the Contractor has considered in the bid proposal all permanent and temporary utility facilities in the present or relocated positions as specified in the Contract and as revealed by its site investigation. No additional compensation is allowed for delays, inconvenience, or damage sustained due to interference from the utility facilities or the moving operations.

The Contract indicates utility items to be relocated or adjusted and who is to perform the work. The Contract indicates the means of adjudication, if any, if the utility owners fail to relocate or adjust the facilities.

105.07 COOPERATION BETWEEN CONTRACTORS. The Department reserves the right to contract for and perform other or additional work on or near the work for the project.

Conduct the work without interfering with or hindering the progress or completion of the work by other contractors. Cooperate with other contractors working within the limits of the project.

Each contractor involved shall accept all liability, financial or otherwise, in connection with the Contract and protect and save harmless the Department from damages or claims that may arise because of inconvenience, delay, or loss experienced because of the presence and operations of other contractors working within the limits of the same project.

Coordinate and sequence with the work of other contractors. Do not store materials, tools, machinery, and other equipment in locations that interfere with the work of other contractors.

105.08 CONSTRUCTION STAKES, LINES, AND GRADES.

105.08.1 Bluetop Staking. The Department will set construction stakes establishing lines, slopes, and profile grade for road work, excluding finish grade stakes (bluetops). The Department will set centerline and bench marks for culverts, protective and accessory structures and appurtenances as determined necessary. The Project Manager will furnish all necessary information relating to lines, slopes, and grades. Use these stakes and marks as the field control to perform the work.

Set the finish grade stakes (bluetops) using a Montana registered Land Surveyor. Hire survey personnel that are trained, experienced, and skilled in construction layout and staking. Do not hire a Department employee to perform the bluetop staking.

A. Perform the following using copies of the Department's bench level and transit notes:

1. Re-establish roadway centerline;
2. Calculate the bluetop grades for subgrade and each base course from the plan information. Consult the Project Manager regarding establishing bluetop grades for curve runoffs and ramps;
3. Set a bluetop line at centerline and each shoulder to establish the correct grade elevations at the subgrade and the top of each full course of each grade of base gravel. Do not exceed 20 feet (6 m) between adjacent lines in any case. Additional bluetop lines are required for additional passing or climbing lanes, and slope or crown breaks between shoulders. Set all rough grade stakes required to control the work. On typical sections using special borrow, the top of the special borrow is considered the subgrade for the purpose of bluetopping;
4. Set bluetop lines for safety shoulders, median and shoulder ditches at 100 foot (30.5 m) intervals.

   Furnish the number of bluetop stake lines meeting the Department Survey Manual requirements and standard engineering practice to produce the typical sections and finish surface quality required by specification. Set subgrade bluetops at maximum 100 foot (30.5 m) intervals for tangent sections and 50 foot (15 m) intervals for curves. Set bluetop staking intervals for base gravel at maximum 50 foot (15 m) intervals for tangents and curves. Reduce the above intervals as required for extreme curvature and grade changes on ramps and frontage roads.

   Drive each stake top to within 0.05 feet (15 mm) of the required elevation.

   Furnish all stakes for bluetop staking. The stakes must be wedged shaped measuring 1½ X 1½ X 10-inches (38 X 38 X 250 mm) minimum.

   Run a level circuit to check the project bench marks on each roadway section being staked.

   Keep field survey notes in a standard field notebook, written in a clear, orderly, neat manner meeting the Department Survey Manual requirements and standard engineering practice. Use Department furnished field notebook paper. The Project Manager will randomly inspect the notes for acceptance. The finished notes become the Department's property.

   Finish the work to meet the contract requirements. Correct all deficient work caused by incorrect staking and reset all bluetop stakes lost or destroyed by traffic or construction at Contractor expense.

105.08.2 Bridge Survey. The Department will establish control points defining median or roadway centerline, bridge centerline, and benchmarks for elevation control.

Establish and maintain all other survey controls required to control bridge alignment and grade meeting the plan dimensions and elevations using a Montana registered land surveyor. Use survey personnel trained, experienced, and skilled in construction layout and staking. Do not hire Department personnel to perform survey work. Use Department furnished field note book paper. Furnish all stakes, steel pins, lath, and other materials required to establish and maintain the survey control points.

Furnish horizontal and vertical control meeting the Department's Survey Manual requirements. Furnish the Project Manager the original survey notes upon request. Furnish the Project Manager copies of the notes showing the initial layout and primary controls and references and the method of independent check before starting work on the substructure units. Submit to the Project Manager a copy of the structure excavation cross section notes 24 hours before starting excavation. The Project Manager reserves the right to re-survey any pay item area.

Make calculations from the plan information to control alignment and elevation. Correct all mis-locations, mis-alignments, and incorrect elevations caused by Contractor calculations, layouts, and surveys at Contractor expense. Submit the proposed method of correction to the Project Manager for approval. Do not begin the corrective work until the proposal has been reviewed and approved.

105.08.3 METHOD OF MEASUREMENT.

A. **Bluetop Staking.** Road construction staking is measured by the course mile (kilometer) along the roadway centerline to the nearest 0.1 mile (10 m). A course mile (course kilometer) is one mile (one kilometer) for each two-lane roadway including shoulders and ditches. Each traffic lane is considered as one-half course mile (one-half course kilometer) including the adjacent shoulder, ditch, parking, turning, median lanes, and chain up areas.

   The subgrade and each gravel course requiring bluetop staking are measured separately by the course mile (course kilometer) for each roadway section, each ramp, each intersecting roadway, each PTW connection and temporary detour, and each frontage road.

B. **Bridge Survey.** Bridge survey is a lump sum item.

105.08.4 Basis of Payment. Payment for the completed and accepted quantities is made as follows:

Pay Item	Pay unit
Bluetop Staking	Course Mile (kilometer)
Bridge Survey	Lump Sum

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

105.09 AUTHORITY AND DUTIES OF PROJECT MANAGER. Each project will be staffed with a Project Manager who is the Engineer's direct representative. The Project Manager has immediate charge of the engineering details of each construction project and is responsible for the administration and satisfactory completion of the project.

The Project Manger can :

1. Reject defective material;
2. Suspend work being improperly performed;
3. Execute any authority delegated to the Project Manager by the Engineer.

The Project Manager will be identified before work begins.

105.10 AUTHORITY AND DUTIES OF INSPECTORS.

Department inspectors are authorized to:

A. Inspect all work being done and materials furnished. Inspection extends to all or any part of the work and to the preparation or manufacture of the materials to be used. Inspection does not relieve the Contractor's obligation to perform the work as specified in the Contract.

B. Reject materials or suspend the work until the issue can be referred to and decided by the Project Manager.

Inspectors cannot :

1. Revoke, alter, enlarge, or relax any requirements of the Contract;
2. Final approve or accept any portion of work;
3. Issue instructions contrary to the Contract.

If the Contractor believes it has been given instructions contrary to the Contract by an Inspector, immediately advise the Project Manager in writing to seek clarification. The Inspector or Project Manager will not act as superintendent for the Contractor or interfere with the Contractor's management of the work.

105.11 INSPECTION OF WORK. All work is subject to Department inspection. Allow the Inspector access to all parts of the work and furnish information and assistance necessary to make a complete and detailed inspection. Provide a safe environment for the inspector during the inspections.

Remove or uncover portions of the finished work as directed. Once examined, restore the work to the contract requirements. If the work is acceptable, the uncovering, or removing and replacing the covering or making good the parts removed will be paid for as extra work. If the work is unacceptable, the uncovering, removing, and replacing the covering or making good the parts removed is at Contractor expense.

Work done or materials used without inspection by an authorized Department inspector may be ordered removed and replaced at Contractor expense.

When a government agency, political subdivision, a utility or railroad is to accept or pay a portion of the cost of the work covered by the Contract, the organization's representatives may inspect the work. The inspection does not make that entity a party to the Contract and shall not interfere with the rights of either party to the Contract.

105.12 REMOVAL OF UNACCEPTABLE AND UNAUTHORIZED WORK. Work not meeting the Contract requirements is unacceptable, unless determined acceptable under Subsection 105.03.

Remove and replace any unacceptable work before final acceptance at Contractor expense. This requirement has full effect regardless of the fact that the unacceptable work or defective materials were known or overlooked by the inspector.

Work done contrary to instructions received, or beyond the plan limits, or extra work done without the permission of the Project Manager will not be considered for payment. Work so done may be ordered removed, restored or replaced at Contractor expense.

Neither the Contractor nor the Department shall incur any liability by reason of any verbal directions or instructions received from the Project Manager. The Department will not be liable for extra materials furnished or used, or for extra work or labor done, unless required by written order from the Project Manager.

If the Contractor fails to follow any order made under this Subsection, the Project Manager has the authority to remove, replace, or restore the work and deduct the costs from any monies due or to become due the Contractor.

105.13 VACANT.

105.14 VACANT.

105.15 ACCEPTANCE.

105.15.1 Partial Acceptance. When a unit or portion of the project, such as a structure, an interchange, a group of signs or delineators, or a section of road or pavement is substantially complete, a final inspection of that unit may be requested. If the Engineer finds that the unit has been completed to the Contract requirements, the unit may be accepted as complete and the Contractor may be relieved of further maintenance for that unit. Partial acceptance does not void or alter any of the Contract terms. The Engineer does not have to accept a portion of the project before final acceptance.

105.15.2 Final Acceptance. Upon notice of completion of the entire project, the Engineer will arrange to make a final inspection. Where all work is complete but deferment of final inspection is necessary for causes outside the Contractor's control, the Engineer will issue a suspend work order and time charges will cease. If the Contract is found satisfactorily completed, the inspection will constitute the final inspection. The Engineer will issue a Certificate of Completion that the work was completed as of the date of the final inspection.

If the inspection discloses unsatisfactory work, the Engineer will issue instructions on the necessary corrections. Immediately comply with the instructions. When the deficiencies are corrected, another inspection will be made, which constitutes the final inspection.

105.16 CLAIMS FOR ADJUSTMENT AND DISPUTES.

105.16.1 Notice of Potential Claim. Inform the Project Manager immediately upon discovery of a potential problem, disagreement or dispute that could result in a request for additional compensation, time extension or contract change, whether arising under the Contract, its performance, or for any other reason.

Submit a written request detailing why additional compensation, time extension or contract change is warranted. The Project Manager will issue a written response within 3 working days of receipt of the request. Should the Contractor disagree with the written decision, instruction, or action, submit within 3 working days of receipt of the written response a fully completed Notice of Potential Claim Form, available from the Project Manager.

Specify in the Notice of Potential Claim all objections to the Project Manager's response and the basis for and amount of any additional compensation, extension of time or contract change.

Immediately begin to keep and maintain complete, accurate, and specific daily records of the potential claim details, starting at the time the Notice is filed. Use the Department's Cost Record of Potential Claim Form available from the Project Manager. Base equipment costs on the Contractor's internal rates for ownership, depreciation, and operating expense.

Allow the Project Manager access to and provide copies of all records when requested.

Make other records available for technical and audit evaluation after the work has been performed.

The Contractor waives all claims for additional compensation, time extension or Contract change by:

A. Failing to timely file a Notice of Potential Claim;
B. Failing to timely file a formal claim;
C. Failing to keep timely and complete detailed daily records; or
D. Failing to submit claims updates as are required.

105.16.2 Submission of Claims. Submit the claim in writing to the Project Manager within 30 calendar days following submission of a Notice of Potential Claim. Specify all reasons for each requested item of additional compensation, time extension, or Contract change, referenced to the applicable provisions of the Contract. Submit verified claim cost records on forms provided, and any additional information pertinent to the claim.

Promptly furnish in writing any clarification or additional information or data requested by the Engineer.

Submit claim updates every 30 calendar days until all costs have been incurred, or the Department approves the claim.

105.16.3 Decision on Claims. The District Engineer will provide a written decision on the claim within 30 calendar days of receipt of the formal claim. Appeal of the Engineer's decision must be made in writing to the Board of Contract Appeals. Submit any appeal by letter to the Construction Engineer of the Construction Bureau through the District Engineer within 30 calendar days of receipt of the decision. The District Engineer's decision is final if not appealed within 30 calendar days. If

appealed, the District Engineer will forward the original claim, supporting documents or evidence, and the District's evaluation to the Construction Engineer.

The Board of Contract Appeals consists of the Chief Engineer, the Operations Engineer and the Chief Counsel, with the Construction Engineer as Secretary to the Board.

The Board of Contract Appeals will review only those documents and evidence submitted in the original claim, its supporting documents, and the District's evaluation, but may request further information from the District Engineer or Contractor.

The Board may affirm, overrule, or modify, in whole or in part, the decision of the District Engineer. The decision of the Board of Contract Appeals is a final decision.

105.17 PARTNERING. Partnering is the formation of a partnership between the Contractor, its principal subcontractors and suppliers, and the Department. Partnerships draw on the strengths of each organization to identify and achieve mutual goals. The objectives are effective and efficient contract performance and completion of all work within budget, on schedule, and meeting the contract requirements.

Partnerships are bilateral in makeup and participation is voluntary. The costs of the partnership are mutually agreed to and shared equally. Partnerships are not a contract requirement and the cost is not to be included in the Contractor's bid. Notify the District Engineer of the intent to partner the project before the Notice to Proceed Date and the Pre-Construction Conference. The Contractor's management personnel and the District Engineer are to organize a Partnering-Team Building Workshop as follows:

A. Facilitator. Select a third party facilitator, with the District Engineer's concurrence, to conduct the workshop.

B. Attendees. Required to attend are the District Engineer, District Construction Engineer, Project Manager, and key project personnel; the Contractor's Project Superintendent and key supervisory personnel, its principal subcontractors and suppliers. Invitations should be made to project design personnel, key specialty or technical personnel, utility management personnel, FHWA, key local or state agency personnel who could impact the project. The Contractor or Department may have other high level managers attend.

One purpose of Partnering is to avoid disputes and the intervention of attorneys. Attorneys and their paralegals will not be invited to attend workshops.

C. Agenda. The workshop agenda consists of the following as a minimum:

1. Discussion of partnering principles;

2. Development of a project charter with defined goals and objectives;

3. Defined problem solving procedure and evaluation process.

Approximately one third of the workshop is to be devoted to team building and problem solving techniques; with the balance devoted to defining project goals, objectives and issue resolution.

D. Duration. The workshop should typically run one and half days, but may be adjusted based on project cost, complexity, number of stakeholder's, partnering experience of attendees, and number of potential issues.

E. Location. The workshop location is to be at a neutral location, in Montana, as near the project site as possible.

F. Payment. The Contractor is to pay for the facilitator's billed cost and the facility. The Department will pay one-half the costs by Change Order.

Follow-up workshops may be held during the project duration as mutually agreed to.

The Partnership Charter does not change any legal relationship of the parties to the Contract nor does it relieve either party of any terms of the Contract.

SECTION 106
CONTROL OF MATERIAL

106.01 SOURCE OF SUPPLY AND QUALITY REQUIREMENTS.

106.01.1 Source of Supply. Use only materials that meet the Contract requirements.

Material may be inspected and tested at the source of supply before delivery to the project. All materials may be inspected, tested, and possibly rejected before incorporated into the work.

Determine the quality and quantity of materials produced at or developed from any source based on the contract documents and by conducting an independent source investigation.

If payments due the owner of a materials source become delinquent and the owner notifies the Department, a sum equal to the amount of the delinquent payments may be withheld from estimate payments due the Contractor.

106.01.2 Samples, Tests, Cited Specifications. Do not incorporate any material into the work until it is inspected, tested, and accepted by the Department. Remove unacceptable materials from the work at Contractor expense.

Reference to a specification or test designated in AASHTO, ASTM, Federal Specifications, or any other recognized, nonproprietary national organization, is the specification or test method that is current on the date of advertisement for bids and as amended by the Department's Test Method Manual. Copies of individual test methods are available from the Department's Materials Bureau in Helena.

Department material tests are by and at the Department's expense. Where there is a difference in the test methods, the order of precedence for tests will be:

A. The Department's Standard Material Test Methods
B. AASHTO
C. ASTM

Submit representative preliminary materials samples in the specified quantities for testing upon request. The testing of preliminary source samples does not constitute acceptance of the materials. Only materials delivered for incorporation into the work will be accepted or rejected based on the test results specified in the Contract.

106.01.3 Unacceptable Materials. All materials not meeting the Contract requirements will be accepted or rejected under Subsection 105.03.

106.02 LOCAL MATERIAL SOURCES.

106.02.1 General. Local aggregate, borrow and topsoil materials sources include prospected sources, contractor-furnished sources, and mandatory sources.

Provide the source for obtaining local materials unless mandatory sources are specified. When prospected sources are identified in the Contract, use the prospected sources or locate other sources of material. Contractor-furnished sources must be approved by the Engineer. The Contractor must:

A. Provide an approved reclamation plan meeting Subsection 106.02.5 before using any materials source.
B. Comply with Section 106 of the National Historic Preservation Act.
C. Adhere to State and Federal requirements and obtain clearance from the State Historic Preservation Officer before using material from surfacing and borrow sources.

106.02.2 Prospected Sources. Contact the Department for information on Department prospected local material sources.

The Department is not responsible for the quantity or quality of materials indicated in the prospected source reports. Test data included in the reports are based on the samples tested from the exact locations shown using standard tests. No interpretation is made or intended by the Department. Any interpretation is the judgement of the person examining the tests. See Subsection 102.06 concerning verifying quantity and quality by an independent subsurface investigation before submitting a bid.

If a "Surfacing Materials Prospect Report" shows a prospected source to be "Department-Optioned" or "Department-Owned," the material may be available for use, possibly with a royalty or other cost. Do not sell material from Department-owned or Department-optioned sources without a written agreement establishing royalty refunds to the Department.

Follow Department made arrangements with landowners for sampling and obtaining material from the prospected material sources.

Pay all royalties and adhere to all agreed stipulations, including contouring of pits, topsoil conservation and replacement, seeding, repair or obliteration of haul roads, cattleguards, and fencing, the cost of which is incidental to and included in the materials cost.

106.02.3 Contractor-Furnished Sources. Acquire the rights to take materials from contractor-furnished sources and pay all related costs, including costs due to increased haul length, exploring and source development.

The Department will process and test samples to determine the suitability of the material. See Subsection 106.10 for the number of department furnished tests at Department expense.

Arrange with the Project Manager for representative samples to be taken and witnessed by the department at least 30 calendar days before beginning aggregate production. Provide all equipment and labor necessary for the sampling.

Source approval will be based on part or all the following sample test results :

A. Wear Test MT-209 (acceptance);
B. Volume Swell Test MT-305 (acceptance);
C. Trial Mix Marshall Properties MT-306 (informational);
D. Immersion-Compression Test MT-324 (informational);
E. Adhesion MT-309 (informational).

Passing test results are mandatory for wear and volume swell for approving an bituminized material aggregate source. Passing wear test results are mandatory for untreated aggregate sources.

Source approval does not release the Contractor from the responsibility to produce aggregate meeting all specified acceptance requirements.

The Engineer may limit the proportion of natural fines in the total aggregate based on the verified mix design.

106.02.4 Mandatory Material Sources. Use of materials from mandatory sources is a condition for preparing a bid and executing a Contract. Follow the conditions in the Contract for producing materials from mandatory sources.

106.02.5 Reclamation Requirements.

A. General. Reclaim all land used in constructing the project as required by the approved reclamation plan. Comply with the pertinent statutes relating to the open cut mining (Title 82, Ch. 4 MCA); the hard rock mining (Title 82, Ch. 4, Part 3); water quality (Title 75, Ch.5); stream bank preservation (Title 82, Ch. 5, Part 5 and Title 75, Ch. 5); Montana County Noxious Weed Management Act Title 7, Ch. 22 Part 21; and all other applicable federal, state, and local statutes, regulations and ordinances.

The Department of State Lands has final responsibility for administration of the Open Cut Mining Act and the Hard Rock Mining Act and must review and approve all reclamation plans and reclamation work. Follow all directives and instructions issued by the Department of State Lands with regard to reclamation work.

B. Reclamation Plan. Submit a copy of the approved reclamation plan to the Project Manager before removing earth, quarried rock, sand, gravel, or other substance from any materials source. Follow the Department of State Lands "Format For Reclamation Plan" and "Mapping Guidelines" when developing reclamation plans. The format and guidelines are available from:

Department of State Lands
Open Cut Bureau
1625 Eleventh Avenue
Helena, MT 59620
Phone: 406-444-2074

The time allowed for approval of reclamation plans is included in the Open Cut Mining Act, Section 82-4-434, MCA .

C. Reclamation Work. Perform reclamation immediately after removing the necessary material. Leave all slopes in a stable condition and, if topographic conditions permit, grade to no steeper than 3:1 after final grading. Grade the excavated area to maintain the natural contour of the land and blend into the surrounding terrain. Remove or grade all outcroppings to daylight where possible.

Strip and stockpile all topsoil and overburden from the material source, stockpile site, crushing area, and equipment parking areas before excavating material. Salvage all topsoil from all new or widened haul, access, and service roads before grading or surfacing. Reclaim all roads when removal operations are complete. Store overburden or subsoil separately from topsoil and replace before topsoil is replaced on reclaimed areas. Uniformly re-distribute all topsoil to the entire reclaimed area.

Seed all re-topsoiled areas during the first seeding season following grading and topsoil replacement. Contour-seed all slopes steeper than 3:1.

Fence newly seeded, reclaimed areas including roads where required to protect from livestock. Use Type F-3M fence.

Do not locate material sources in a flowing stream or on a stream floodway at a location likely to develop a new channel to the stream during flooding. Leave the final floor elevations of material sources high enough to not be impacted by fluctuations in the groundwater table, unless addressed in the approved reclamation plan. Provide protection and safety of persons and property adjacent to the work.

D. Method of Measurement and Basis of Payment. Reclamation of material sources is incidental to the materials cost.

106.02.6 Protection of Livestock & Property. Prevent livestock from straying into or out of any materials source.

Protect all irrigation facilities from construction operations. Promptly repair or replace damaged irrigation facilities to the landowner's satisfaction at Contractor expense.

106.02.7 Rejects (Excess Fines). Material referred to as "rejects" are inherent in a rock pit, gravel pit, or quarry, or accumulated during crushing and screening operations. Stockpile rejects, from material sources owned or optioned by the Department and not acceptable for use on the project, at a site selected or approved by the Engineer when requested. Stockpiled reject material will be paid for at 15 cents per ton mile (10 cents per metric ton kilometer) for haul in excess of 200 feet (61 meters) from the crusher site to the stockpile.

Retain title to all rejects accumulated during aggregate production from contractor-furnished sources. Department purchased rejects will be paid for at an agreed purchase price.

106.03 CERTIFICATION OF COMPLIANCE. The Contract or the Engineer will designate materials or assemblies that can be incorporated into the work by Certificates of Compliance stating that they meet the Contract requirements. The certificate must be signed by the manufacturer and notarized. Clearly identify each lot of certified materials or assemblies delivered to the work in the Certificate of Compliance.

Materials or assemblies used on the basis of Certificates of Compliance may be sampled and tested at any time. Materials not meeting contract requirements will be rejected.

106.04 PLANT INSPECTION. Meet the following conditions if materials are Department inspected at the source of supply or manufacture:

A. Provide the Inspector full cooperation and assistance during inspections;

B. Provide the Inspector full entry to all parts of the plant used in the manufacture or production of the materials;

C. Furnish the facilities to determine if the material furnished meets contract requirements;

D. Provide and maintain adequate safety measures.

Materials inspected at the source may be re-inspected before incorporation into the work. Materials not meeting the Contract requirements will be rejected.

106.05 FIELD LABORATORY. The Department will furnish all field offices and laboratories.

Furnish 110-120 volt alternating current of sufficient capacity and a potable water supply to operate all testing equipment for the offices and laboratories at Contractor expense.

106.06 RESERVED.

106.07 HANDLING AND STORAGE OF MATERIALS. Store and handle materials to preserve their quality. Stored materials, are subject to inspection and re-testing before incorporating into the work. Locate stored materials for ease of inspection. Obtain approval to use portions of the right-of-way for storage and placing the plant and equipment. Obtain additional required space at Contractor expense. Do not use private property for storage without the landowners or lessees written permission. Furnish copies of the written permission to the Project Manager. Restore all storage sites to original condition at Contractor expense.

Transport bulk materials in vehicles that do not cause material loss or segregation.

106.08 DEPARTMENT-FURNISHED MATERIAL. Department furnished material will be delivered or made available at the locations specified.

Include the cost of handling and placing Department-furnished materials in the contract price for the item.

Be responsible for all Department furnished material. Deductions will be made from any monies due for shortages, deficiencies, and damage that occurs after delivery. Demurrage charges, resulting from failure to accept the material at the designated time and location will be deducted from monies due the Contractor.

106.09 DOMESTIC MATERIALS. Furnish domestic steel or iron materials for permanent incorporation in the work. Domestic material is material that all manufacturing processes, including coating of steel or iron, occur in the United States. Pig iron, and processed, pelletized and reduced iron ore may be manufactured outside the United States. Furnish the appropriate manufacturer's mill tests and certifications documenting the manufacturing processes, including coatings of covered materials, performed in the United States. A minimal quantity of foreign manufactured steel and iron material may be used if the cost of the material, including delivery costs to the project, does not exceed one-tenth of one percent of the total contract amount or $2,500.00, whichever is greater. Do not incorporate steel or iron materials into the project until the proper documentation is furnished to the Project Manager.

106.10 BITUMINOUS AND CONCRETE MIX DESIGNS AND TESTING OF SURFACING MATERIAL SOURCES. The Department will furnish the following at no cost to the Contractor:

Description	Number Furnished per Contract Without Charge
Plant Mix Surfacing Mix Design	2 per grade
Plant Mix Base Mix Design	2 per grade
Open-Graded Friction Course Mix Design	2 per grade
Portland Cement Concrete Mix Design	1 per class
Cement-Treated Base Mix Design	2 per grade
Surfacing Material Testing Package	
(indicated source(s) shown on plans)	2
(surfacing source(s) furnished by Contractor)	2

The Contractor will be charged the Department's cost for each additional mix design and testing package furnished. The total cost will be deducted from the progress estimate payments using the schedule of the current charges for additional testing packages and mix designs available from the Project Manager.

SECTION 107
LEGAL RELATIONS AND RESPONSIBILITIES TO THE PUBLIC

107.01 LAWS, RULES AND REGULATIONS TO BE OBSERVED. Observe and comply with all of the following:

A. Federal and State laws and regulations;
B. Local laws and ordinances; and
C. Regulations, orders and decrees of bodies or Tribal ordinances having any jurisdiction or authority.

Protect and indemnify the Department and its representatives against any claim or liability arising from the violation of any of the above-listed items, whether violated by the Contractor, a subcontractor, materialman, or supplier, or any of their employees or agents.

Follow all rules and regulations of Federal, State, and local health officials. Do not require an employee of the Contractor or subcontractor (s) to work in surroundings, or under conditions that are unsanitary, hazardous or dangerous to health or safety. Admit any inspector of the OSHA or other legally responsible agency involved in safety and health administration without delay and without presentation of an inspection warrant to all areas of the work and project site upon presentation of proper credentials.

Follow Federal, State and local laws, rules and regulations regarding unlawful employment practices including race, religion, color, sex or national origin discrimination, and that define actions required for Affirmative Action and Disadvantaged Business programs.

Work within a State or National Forest is under the regulations of the authority having jurisdiction governing the forest.

Immediately notify the Engineer in writing if any discrepancy or inconsistency is discovered between the Contract and any law, ordinance, regulation, order or decree.

107.02 PERMITS, LICENSES, AND TAXES. Obtain all legally required permits and licenses, pay all charges, fees, and taxes, and give all notices necessary and incidental to the lawful prosecution of the work.

107.03 PATENTED DEVICES, MATERIALS, AND PROCESSES. Do not use any design, device, material, or process covered by letters of patent or copyright, without a legal agreement with the patentee or owner. Indemnify and save harmless the Department, any affected third party, or political subdivision from all claims for infringement for the use of any patented design, device, material or process, or trademark or copyright. Indemnify the Department of all costs, expenses, and damages obligated for payment by reason of an infringement during the prosecution or after the completion of the project.

107.04 RESTORING SURFACES OPENED BY PERMIT. The Department may grant permits to construct or re-construct a utility facility in the highway or street for authorities of the municipality in which the work is done. Do not allow any individual,

firm, or corporation to make an opening in the street without a Department permit. Do not allow any person or persons to make an opening unless authorized by the Engineer. Parties bearing permits may make openings in the street. When requested by the Engineer, repair these openings. The work will be paid for under Subsection 104.03 or as provided in the Contract. Repair to the same standards as the original work.

107.05 FEDERAL AID PARTICIPATION. Federal laws, rules, or regulations in conflict with any provisions of a federally assisted Contract prevail and take precedence over conflicting Contract provisions.

Federally assisted work is under Department supervision and subject to inspection and approval of the United States Government. Inspections by authorized Federal representatives do not make the United States a party to the Contract and will not interfere with the rights of the Contract parties.

107.06 PUBLIC CONVENIENCE AND SAFETY. Conduct construction with minimum obstruction to traffic. Provide safety and convenience to the public and protect persons and property including, but not limited to, items specified in Subsection 104.05 and Section 618.

Do not close public roads without the Engineer's permission.

107.07 RAILWAY-HIGHWAY PROVISIONS. Responsibility for work involving railway property are:

A. Contractor. Perform work on railroad right-of-way without interfering with the movements of trains or traffic on railway property. Do not cross the railway right of way or tracks except at temporary or existing, open public grade crossings.

Furnish signed copies of the "Contractor Requirements and Acknowledgment for Working on Railroad Right of Way" found in the Contract to the railroad and Project Manager before entering railroad property and starting work.

Provide advance notice, as agreed to between the Contractor and railway officials, before working on railway property, hauling across railway tracks, or blasting within 1000 feet (305 m) of railway property.

Comply with Subsections 107.09 and 107.18 when blasting or performing other work on or near railway property.

Furnish insurance for all work performed as required by Subsection 107.13 or the Contract. Make arrangements with the railway company for railway crossings not specified in the Contract at Contractor expense.

Reimburse the railroad company for all costs of railway flagging, other protective services, and installation of temporary crossings for haul roads for contractor-furnished material sources based on billings submitted by the railway company.

B. Department. The Department will:

1. Enter into an agreement with the Contractor and the railway company when required by the railway company;
2. Arrange for railway crossings specified in the Contract and pay for the crossings, railway flagging and other protective services necessary for

work performed on or near railroad right of way, including haul road track crossings to Department-optioned or owned material sources;

3. Forward billings for flagging, track crossings, and other protective service billings for contractor-requested crossings, submitted to the Department by the railway company.

C. **Railway**. Railway companies will:

1. Furnish all flagging or other protective service as necessary for the safe operation of trains or traffic on railway property;
2. Construct, maintain, protect, and remove temporary crossings and submit billings for flagging or other protective services to the Contractor or Department.

107.08 LOAD RESTRICTIONS. Do not exceed legal load restrictions when hauling material and equipment on public roadways and bridges within and beyond the project limits and on all new and existing portland cement concrete roadways, treated base courses, bituminous surfacing lifts and courses, including plant mix base, plant mix surfacing, and open-graded friction course.

Do not place loads on a concrete pavement, treated base, or structure before the curing period has been achieved.

Repair damaged roadways and structures resulting from construction operations at Contractor expense.

Measure and analyze truck legal load limits by the bridge formula before hauling any material over existing or newly-paved roadways and bridges. Furnish a drawing showing distances between axles, truck tare weight, and the overall length of each truck.

Show a minimum of two applications using the bridge formula on the drawing. Include on the first application the overall length between axles. For the second application, do not consider the steering axle, and add the value obtained from the bridge formula to the anticipated load on the steering axle. Use the lesser of the two values obtained as the legal load. Retain a copy of the appropriate drawing in each truck. Do not exceed established legal load weights for single axle and tandem axles.

The weight on a truck in excess of the maximum legal weight as determined above will be deducted from the quantity considered for payment.

Comply with this provision and all applicable laws, rules, and regulations related to operation of motor vehicles on public roads.

Trucks operated on public roads may be checked by the Department's Motor Carrier Services and fines levied for exceeding legal loads.

Do not use existing bridges, new bridges, or bridges to be removed but still in use by the public as work platforms, work bridges, or to support or move equipment without the Engineer's written approval.

Approval will be granted only where load analysis and review of traffic control, safety, and convenience show it to be in the public interest.

No additional compensation will be considered or allowed for any violation of these provisions.

107.09 USE OF EXPLOSIVES. Transport, store, handle, and load explosives and blasting agents following all laws and ordinances as well as the applicable

requirements of Title 29, Title 30, and Title 49 of the Code of Federal Regulations when using, handling, loading, transportation, and storing explosives and blasting agents.

Use explosives without endangering life or property and be responsible for all resulting property damages, injury, or death.

Only use persons experienced in the handling of explosives and do not fire explosives until sounding a warning and removing all persons from the radius of danger.

Notify each property owner, railway company, and public utility company having facilities near the blasting area of the intent to use explosives to enable them to take precautions to protect their property from injury. Be responsible for damages to property or injury to persons attributable to the use of explosives.

107.10 PROTECTION AND RESTORATION OF PROPERTY AND LANDSCAPE. Preserve all public and private property when performing work. Do not disturb or damage land monuments and property markers until witnessed or referenced by the Project Manager.

Be responsible for all damage to public and private property resulting from any act, omission, neglect, or misconduct in the manner or method of executing work until the project is accepted.

Replace or restore damaged property to its original condition at Contractor expense.

107.11 ENVIRONMENTAL PROTECTION.

107.11.1 General. Follow all State, local, and Federal laws and regulations controlling pollution of the environment. Take precautions to prevent pollution of streams, lakes, ponds, reservoirs, and wetlands with silt, fuels, oils, bitumens, chemicals, or other harmful materials. Prevent pollution of the atmosphere from particulate and gaseous matter.

Obtain all required permits and furnish copies of all permits or authorizations to the Project Manager before starting activities requiring permits.

107.11.2 Water Pollution and Siltation Regulations. Attention is directed to Title 75, Chapter 5, MCA, (Water Quality) and the administrative rules of the Water Quality Bureau, Department of Health and Environmental Sciences.

Under the Water Pollution Control Act, Construction De-watering - General Discharge Permits and Short-Term Construction Authorizations are required for construction activities that may result in a violation of water quality standards of streams, lakes, or other bodies of water located on or adjacent to the project.

Under the Federal Water Pollution Control Act, as administered by the U.S. Army Corps of Engineers, Permits Branch, P.O. Box 5, Omaha NE 68101, Section 404 Permits are required for discharging dredged or fill material into wetlands or waters under the jurisdiction of the Corps. Information on Section 404 Permits may be obtained from the Corps offices in Helena (406-444-6670) and Billings (406-657-6891).

Other requirements relating to water pollution control are covered in Section 208.

A. **Construction De-watering - General Discharge Permits.** Obtain a Construction De-watering - General Discharge Permit from the Water Quality Bureau, Department of Health and Environmental Sciences in Helena before de-watering any cofferdam or other excavation. Copies of the permit are available from the Water Quality Bureau. A permit is valid for a project only when accompanied by an authorization letter. Do not start work authorized by a Construction De-watering - General Discharge Permit until the Project Manager is furnished an executed copy of the authorization letter.

The General Discharge Permit may require the treatment of wastewater by pumping the water to retention ponds for clarification or provide other approved treatment.

B. **Short-Term Construction Authorization.** Obtain all Short-Term Construction Authorizations, under ARM 16-20.633(3a), for all operations involving activities or improvements that would violate the Montana Water Quality Standards.

Forms for "Application For Authorization" for short-term construction activities may be obtained from the Water Quality Bureau, Department of Health and Environmental Sciences in Helena.

Applications for Authorization require furnishing the following information:

1. A detailed description of all construction activities that may result in stream sedimentation or turbidity (e.g., riprap work, instream work with equipment, dredging, channeling, excavating);
2. A list of the type of equipment planned for use to accomplish the work described in (1) above and a discussion of how the equipment will be used in conjunction with the project;
3. The date construction activity is anticipated to commence;
4. The estimated completion date;
5. A discussion of the alternatives considered or available for minimizing or eliminating stream sedimentation as a result of construction activity;
6. A location map; plan and elevation drawings showing the temporary facilities relationship to the stream channel. Include photographs if possible.

C. **Section 404 - Nationwide and Individual Permits.** Attention is directed to the Federal Water Pollution Control Act. Follow the provisions of this act, with special attention directed to Section 404.

Construction activities in and around wetlands or waterways may be covered by a U.S. Army Corps of Engineers Nationwide Permit or may require an individual Section 404 Permit. Obtain all permits necessary for activities relating to the construction that are not covered by a Section 404 Permit already obtained by the Department. These activities may include, but are not limited to, temporary fills and berms, haul roads, work bridges, and the like, which require fill below the ordinary high-water limits of streams, wetlands, lakes, or other water bodies under the jurisdiction of the Corps.

The Contract will include any additional conditions and requirements for applicable Section 404 permits.

107.11.3 Air Quality. Operate all equipment including, but not limited to, hot-mix paving plants and aggregate crushers to meet the minimum air quality standards established by Federal, State, and local agencies.

No additional payment will be made for the use or installation of dust or smoke control devices, for the disruption of work or loss of time occasioned by the installation of such control devices, or for any other related reasons.

107.11.4 Noise Pollution. Follow all applicable laws and regulations and all requirements contained in the Contract regarding noise pollution.

The Contract may include additional requirements for projects located in or near urban areas.

107.11.5 Noxious Weed Management. Follow the requirements of the County Noxious Weed Management Act, Title 7, Chapter 22, Part 21, and all county and contract noxious weed control requirements. Determine the specific noxious weed control requirements not specified in the Contract of each county where the project is located before submitting a bid.

All costs incurred to meet the weed control requirements are incidental to other items of the Contract.

107.11.6 VACANT.

107.12 FOREST PROTECTION. Observe sanitary laws and regulations regarding the performance of the work within or adjacent to State or National Forests and Parks. Keep all areas in an neat condition, dispose of all refuse, and obtain permits for the construction and maintenance of construction camps, stores, warehouses, residences, latrines, cesspools, septic tanks, and other structures.

The Contractor, subcontractors, and their employees shall prevent, suppress, and assist in preventing and suppressing forest fires, and immediately notify a forest official of the location and extent of any fire discovered.

Maintain spark arresters to meet the Forest Supervisor's requirements on all steam, gas, or diesel-driven machinery used and on all flues at construction camps.

107.13 INSURANCE REQUIREMENTS.

107.13.1 Insurance On All Contracts. Obtain commercial general liability insurance with a general aggregate limit of $2,000,000; an occurrence limit of $1,000,000; and products and completed operations limit of $1,000,000.

Obtain a policy that:

A. Provides coverage on an occurrence basis and not on a claims made basis;

B. Provides the owners and contractor protective coverage with the same limits as the commercial general liability insurance, with the State of Montana, its agents, employees, and officers as an additional named insured;

C. Does not contain exclusions for explosion, collapse, and underground damage hazards.

Do not start work until the Department has been furnished evidence that adequate insurance has been obtained.

107.13.2 Insurance Involving Railroads. Furnish Railroad Protective Liability Insurance on behalf of the railroad when equipment or personnel are located or work is done on any railroad right of way.

The limits of liability are specified in the Contract.

Obtain public liability and property damage insurance as specified in Subsection 107.13.1 before working within 50 feet (15.25 m) from the nearest rail but still on railroad property.

Submit copies of the Railroad Protective Liability Insurance policy, and a certificate of insurance required in Subsection 107.13.1 to the Engineer for transmittal to and approval by the railroad. Do not use or enter railroad property until railroad approval is received and the policies are in effect. This applies to all work done as a part of the project.

107.13.3 Insurance On Contracts Involving Utility Property and Services. See Subsection 107.18 for additional insurance required on contracts involving utility property and services.

107.13.4 General. Furnish insurance policies with an endorsement that prohibits canceling, altering, amending or reducing coverage without giving a minimum of 30 calendar days written notice by the insurance company to the insured and the Department. Keep the required insurance in full force and effect until all work has been satisfactorily completed and accepted under the terms of the Contract. All insurance policies issued under the Contract must be countersigned by a Montana resident agent. If the state where the insurance is being purchased has a reciprocal agreement with the State of Montana and the insurance company is licensed to do business in the State of Montana, a countersignature by a Montana Resident Agent is not required.

107.14 THIRD PARTY BENEFICIARY CLAUSE. It is specifically agreed between the parties to the Contract that it is not intended to create anyone as a third party beneficiary or to authorize anyone not a party to the Contract to maintain an action for damages pursuant to the terms or provisions of the Contract.

107.15 RESPONSIBILITY FOR DAMAGE CLAIMS. Indemnify and save harmless the Department and the Department's officers and employees from all actions or claims brought because of injuries or damages to persons or property caused by the actions or omissions of the Contractor's employees or agents.

107.16 OPENING SECTIONS OF PROJECT TO TRAFFIC. The Engineer may open certain sections of the work before completion or acceptance of the Contract. Opening these sections does not constitute acceptance of the work, or waive any Contract requirement.

Pending completion and acceptance of the roadway, complete all repairs or removals on sections of opened roadway caused by defective materials, work or by causes other than ordinary wear and tear meeting Subsection 107.17 requirements.

If shoulders, drainage structures, or other elements of the work are not completed on schedule, the Engineer may order all or a portion of the project open to traffic. Liability and responsibility for maintaining the work before final acceptance remains in effect. Complete the remaining work with minimum interference to traffic.

107.17 CONTRACTOR'S RESPONSIBILITY FOR WORK. Protect the work against loss, injury, or damage caused by the elements, traffic, or any other cause, including, but not limited to, fire, theft, pilferage, vandalism, or third-party negligence until final acceptance. Rebuild, repair, and restore all loss, injury and damages to the work resulting from the above causes before final acceptance at Contractor expense.

Rebuilding, repairing, and restoring damage to the work due to unforeseeable causes beyond the control of and without the fault or negligence of the Contractor (including, but not restricted to: acts of God such as earthquake, flood, tornado, or other cataclysmic phenomenon of nature or acts of the public enemy or of governmental authorities) will be paid for under Subsection 104.03. This does not excuse, or allow compensation or repayment for any act or omission by the Contractor or its subcontractors, either in violation of law, regulation, ordinance, etc., or for any act or occurrence which could have or should have been foreseen.

Expect probable adverse weather and stream flow conditions to occur. The cost of delay, loss, injury, or damage occurring to dikes, cofferdams, caissons, work bridges, haul bridges, or any other construction item or equipment, caused by adverse weather and stream flow conditions is the Contractor's responsibility.

The above requirements do not apply to units or portions of the project accepted under Subsection 105.15.1.

Repair of damage not caused by the Contractor to installed delineators, impact attenuators, median barrier, guardrail, guideposts, light poles, sign supports, and the like, that have been accepted as complete and to any building that has been completed in its entirety, is fully functional, and is open to the public, will be paid for under Subsection 104.03.

Payment for repair of damages resulting from public traffic and use does not entitle the Contractor to:

A. The release of any part of retained percentages;
B. Relief from responsibility for defective workmanship or materials;
C. A waiver of any Contract provision.

Conduct the work to assure maximum convenience and safety to the general public and to the property owners adjacent to the work.

Maintain access for adjacent property owners at all times.

Take precautions to prevent damage to the project during work suspensions. Provide for drainage and erect all necessary temporary structures, signs, or other facilities at Contractor expense.

107.18 CONTRACTOR'S RESPONSIBILITY FOR UTILITY PROPERTY AND SERVICES. Arrange to protect railway, telegraph, telephone, and power companies property or other property from damage, loss or inconvenience before starting work. Cooperate with the utility owners in the removal and rearrangement of underground or overhead utility lines or facilities to minimize interruption to service and duplication of work by the utility owners.

Call the Utilities Underground Location Center (1-800-424-5555) or other notification system for the marking and locating of the utilities before excavation. Do not damage underground facilities during excavating and backfilling work.

Obtain and carry comprehensive insurance covering underground work and resulting damage to underground utilities in addition to the insurance required by Subsection 107.13.

Provide and maintain temporary drainage facilities if existing surface drainage, sewers, or underdrains are interrupted at Contractor expense until permanent drainage facilities are completed. Protect and preserve existing tile drains, sewers, or other subsurface drains, conduits, and other underground structures affected by construction that can remain in use without any change.

Promptly notify and cooperate with the utility company if utility services are interrupted due to an accidental break until service has been restored.

Do not begin work around fire hydrants until provisions for continued service have been made and approved by the local fire authority. Provide continuous repair until service is restored if water service is interrupted.

Repairs to damaged utility facilities or structures resulting from construction operations and negligence is at Contractor expense. Be responsible to the utility owners and operators for damage, injury, expense, loss, inconvenience, or delay or for any legal suits, actions, or claims that may result from the work. The Commission may require the Contractor to furnish protective public liability and property damage insurance to each corporation, company, partnership, or individual owning or operating the properties affected.

107.19 FURNISHING RIGHT-OF-WAY. The Department will obtain all right-of-way for the project.

Exceptions will be noted in the bid proposal and award of the Contract may not be made until right-of-way is obtained. The submission of a bid is an affirmative statement that the bidder accepts this condition and waives any damage that could be claimed.

Claims for damage or loss of anticipated profits because of this delay will not be considered by the Department. Consideration will be given for an appropriate extension of the contract time if the award is substantially delayed.

107.20 PERSONAL LIABILITY OF PUBLIC OFFICIALS. The Department, and its authorized representatives are acting solely as agents and representatives of the State when carrying out or exercising the power or authority granted under the Contract.

There shall not be any liability on them either personally or as officials of the State.

107.21 NO WAIVER OF LEGAL RIGHTS. Once the work is complete, the Department will expeditiously make final inspection and notify the Contractor of acceptance. Final acceptance will not prevent the Department from correcting any measurement, estimate, or certificate made before or after contract completion and from recovering from the Contractor, or surety, or both overpayment's sustained for failure to fulfill the obligations under the Contract. A Department waiver of any

breach of any part of the Contract does not constitute a waiver of any other or subsequent breach.

Be liable to the Department for latent defects, fraud, or gross mistakes as may amount to fraud, or with regards to the Department's rights under any warranty or guaranty.

107.22 PROTECTION OF ARCHEOLOGICAL AND HISTORICAL FINDINGS. Provide the Project Manager written evidence that no historic or pre-historic sites on or eligible for listing in the National Register of Historic Places are located on property used for construction activities that are outside of the Department obtained right of way, easements, material sites, or other areas designated in the Contract before construction starts. These areas include but are not limited to staging areas, contractor furnished material sites, or other related areas to be used for the work.

Submit the legal descriptions, the acreage (hectares) involved, a description of the work activity, a site plan, and a description of the ground surface of all sites not included in the contract plans. Forward the submittal to the Montana Department of Transportation, Environmental and Hazardous Waste Bureau Archeologist (Phone 444-0455). Within 10 working days, the Department will notify the Contractor if the presence or potential of cultural resources exists in the areas and recommend if a professional cultural resource survey is needed or not needed. If a survey is not recommended, no further cultural resource work is required.

If a survey is recommended, hire a professional cultural resource contractor perform a survey. A directory of cultural resource contractors is available from the Department Archeologist.

If the survey does not identify any historic or pre-historic site within the area of proposed disturbance the Department will issue a notice to proceed with the work. If the cultural resource contractor or the Department identify any historic or pre-historic sites within the proposed area of disturbance, the Department, in concert with SHPO will determine whether the site(s) may be eligible for listing in the National Register of Historic Places.

Choose one of the following options if a site is eligible.

A. Do not use or disturb the proposed site;

B. Request the Department to proceed with the steps to comply with 36 CFR 800. Use a professional cultural resource contractor to perform all field work, surveys, etc. required to complete the process identified by the Department. No additional compensation or delay considerations is allowed under these requirements.

Immediately stop work if archeological or historical artifacts are encountered. Immediately notify the Project Manager of the find. The Project Manager will stake the area to remain undisturbed until further notice.

107.23 DISCOVERY OF UNDERGROUND STORAGE TANKS. Take the following action if an underground storage tank or tanks are encountered, the existence or location which was previously unknown to the Department or Contractor, on the project within the highway right-of-way, or in any other area of the project, including the Contractor's own work areas :

A. Immediately stop work in the vicinity and notify the Project Manager of the find.

B. Immediately notify the local fire authority and, within 24 hours notify the State authority if there is evidence of a tank leak or pipe leak. The state authority to be contacted is:

Underground Storage Tank Program
Department of Health and Environmental Sciences
Solid and Hazardous Waste Bureau
Cogswell Building, Room B201
Helena, MT 59620
(406) 444-5970

C. Immediately protect people and property from fire, explosion, vapor, and other potential hazards and, prevent further release of the tank's contents and take all actions requested by the Underground Storage Tank Program personnel.

D. Perform the tank closure work as directed by the Project Manager.

E. Do not resume work in the immediate vicinity of the tank until approved.

Costs incurred from the discovery of underground storage tanks within the highway-right-of-way will be paid for as extra work under Subsection 104.03. Costs from the discovery of underground storage tanks outside the highway-right-of-way is at the Contractor's expense.

107.24 DISCOVERY AND REMOVAL OF UNKNOWN HAZARDOUS MATERIALS. If the Contractor discovers hazardous material (i.e., asbestos, PCBs, petroleum, PCPs, hazardous waste or radioactive material, etc.), the existence or location which was previously unknown to the Department and the Contractor and not identified in the contract, the Contractor must immediately stop work in that area. The Contractor will immediately notify the Project Manager. Work may continue in unaffected areas believed to be safe.

The Department will equitably compensate the Contractor under Subsection 109.04.3 for costs associated with the delay to work in the affected area.

Once notified of the contaminated site, the Department will determine whether a separate contractor will be used to assess and clean up the contaminated site before permitting the Contractor to resume work in the contaminated area. The separate contractor will obtain all necessary clearances (procedures, permits, etc.) from the regulatory agencies before starting any work. If the Department, after consulting with the Contractor, determines that the Contractor can perform the work it is subject to Subsection 107.26 and will be paid for under Subsection 109.04.3.

If the Contractor does not want to perform the work, it agrees and accepts that it waives any potential claim for itself, its subcontractors, and suppliers for damages for delay from the Department's securing another contractor to perform the clean-up work.

If the area is determined to pose a hazard to the traveling public, close off all access to the area as directed.

107.25 ACCESS TO CONTRACTORS RECORDS. Allow access to all records, and the records of all subcontractor's, under Section 18-1-118 MCA, by the Legislative Auditor and Legislative Fiscal Analyst to determine compliance with the terms of the Contract.

107.26 LIABILITY FOR CERCLA/CECRA CLAIMS. The Department will indemnify, protect, and hold harmless, the Contractor for any actions which the Department specifically directs or reasonably requires the Contractor to perform only if said action is the subject of litigation or administrative action under CERCLA, 42 U.S.C. §9601, et seq., or CECRA (§75-10-701 et seq., MCA), and it does not fall within the exceptions below.

The Contractor shall indemnify, protect, and hold harmless the Department for any omissions or actions not specifically directed by the Department if said omissions or actions are the subject of litigation or administrative action pursuant to CERCLA or CECRA. Actions or omissions which are chosen either in type, scope, location, amount or method by the Contractor are not "specifically directed or reasonably required" by the Department.

The Contractor shall further indemnify, protect, and hold harmless, the Department for any negligent actions by the Contractor, its subcontractors, their employees or agents, including any actions that may be the subject of litigation or administrative action pursuant to CERCLA or CECRA.

When the Contractor is directed by the Contract to obtain hazardous material liability insurance coverage for a project, that contract requirement controls and has priority over this specification.

SECTION 108
PROSECUTION AND PROGRESS

108.01 ASSIGNMENT OR SUBLETTING OF CONTRACT.

108.01.1 Assignment of Contract. Do not assign, sublet, transfer, convey, or dispose of more than 60% of any portion of the Contract cost without the written consent of the surety and the Department.

Include in the written assignment or subcontract, or in a separate written assignment with the assignment or subcontract the following language.

"In consideration of being awarded this subcontract, and in consideration of having this subcontract approved by the State of Montana, the Subcontractor hereby assigns to the State of Montana any and all claims or causes of action for any antitrust law violations, or damages arising therefrom, as to goods, materials, and services purchased under the terms of this subcontract or any change order that may result from this subcontract."

108.01.2 Subletting. Perform at least 40% of the Contract cost with the Contractor's organization. Designated Contract "Specialty Items" may be performed by subcontract without regard to the 40% limitation.

Where an entire item is subcontracted, the percentage of the total work subcontracted is based on the contract item bid price. When a portion of an item is subcontracted, the percentage of the work subcontracted will be based on either the subcontract item unit price or on an estimated percentage of the contract item bid price, determined by the Engineer.

Do not allow any Subcontractor to start work until its subcontract is approved by the Construction Engineer in Helena. Include three executed and certified copies of the subcontract, a letter from the surety consenting to the subcontract, and a copy of the proposed subcontractor's current special fuel users permit issued under 15-70-302, MCA.

Do not assign more than the allowable 60% by including additional labor, equipment, and supervision costs on the Contractor's payroll records to circumvent the subcontracting provisions.

Inform the subcontractor of all the Contract provisions. The minimum wage included in the Contract applies to labor performed on all work sublet, assigned, or disposed of.

Attach to each subcontract all required Contract provisions and predetermined minimum wage rates. Include in the subcontract these words: "The subcontractor agrees to comply with all of the labor provisions contained in the attached "Special Required Contract Provisions" and "Minimum Wage Determination."

All subcontractors are agents of the Contractor. The Contractor is responsible for all work, material furnished, and indebtedness incurred by the subcontractor.

Written consent to sublet or transfer the Contract does not release the Contractor from liability under the Contract and bond.

108.02 NOTICE TO PROCEED. Work is to begin and time charges will start on the date stipulated in the "Notice to Proceed".

If work cannot begin on the date in the Notice to Proceed due to reasons beyond the Contractor's control, these conditions, dates, and reasons will be recorded in the weekly "Assessment of Contract Time" and no time will be charged. Begin work when the Engineer determines and issues a notice to resume work and that assessment of contract time will start.

108.03 PROSECUTION OF WORK. Submit to the Engineer within 5 calendar days of award, 2 copies of an Activities Schedule Chart (ASC) and Written Narrative (WN) that details the time (working days or completion date) involved to complete the major contract items for the duration of the Contract. Include in the ASC:

A. A bar chart chronologically sequenced and to time scale showing all major work items and their construction prosecution and preparation activities;
B. Activity descriptions for each item relative to the project;
C. Activity durations by working days or calendar days as appropriate. Note the non-working periods exceeding three days on each activity bar.

Include in the Written Narrative:

A. The proposed work process sequence showing the interdependence of all major work items required to complete all work items under the Contract, including shop drawing submittal's, permits, fabrication, and delivery activities, etc;
B. A description of work activities and the progress time of each major work item measured by working day or calendar day as appropriate;
C. A description of the ASC, work days per week, holidays, number of shifts per day, hours per shift, and resources used.

Submit 2 updated ASC and WN monthly showing current progress and any revisions or modifications to reflect changes in the method or manner of the work, specification changes, extra work, changes in duration, etc.

Prosecute the work with adequate resources to complete the Contract within the time specified.

Obtain all air quality, water quality, and storm water runoff permits, approval of reclamation plans, and archaeological and historical clearances immediately upon the Notice of Award of Contract. Furnish copies of completed applications to secure permits, approvals, or clearances to the Engineer.

The Department will reimburse all reasonable costs incurred in securing the permits, approvals, and clearances if the contract is not executed.

A preconstruction conference will be held on a mutually agreed date between the Contractor, Department, and other parties interested in the work before construction starts. The Contractor's superintendent in charge of the construction must attend the conference. Encourage Subcontractors to attend.

Obtain the Project Manager's written approval before starting night work. Furnish flood lighting to assure accuracy and quality of workmanship. Do not rely only on equipment lights. Night work approval may be rescinded at any time.

Suspending and resuming work on all or any part of the Contract will be by Subsection 105.01.

Work may be suspended for unsuitable weather or for other conditions that are detrimental to the work accuracy and quality. Prevent any damage and correct deteriorated work that was not protected during the suspension period at Contractor expense. A time extension will not be approved for correcting non-protected work.

Store materials to prevent damage and without obstructing or impeding the traveling public.

Do not allow water to pond on the roadway or the construction limits. Open ditches, shoulder drains, and take other actions to protect the work.

Do not suspend work on any part of the Contract without the Engineer's written approval. Time will be charged during unauthorized work suspensions. The Contractor is responsible for all maintenance required during periods of unauthorized suspension and for all work and materials required as a result of the suspension.

Reimburse the Department for all field project engineering charges accrued during any unauthorized work suspension.

108.04 LIMITATION OF OPERATIONS. Conduct the work to minimize interfering with traffic and work already started. Finish a section of roadway before starting work on any additional sections if it is essential to public convenience.

108.05 CHARACTER OF WORKERS. Provide workers with the skill and experience to perform the work.

Remove any person employed who does not perform work in a proper and skillful manner or who is intemperate or disorderly. Do not re-hire these employees without the Engineer's approval.

Failure to remove the employee or employees or failure to furnish suitable and sufficient personnel to perform the work may result in a written notice to suspend the work.

108.06 METHODS AND EQUIPMENT. Use equipment of the size and mechanical condition to perform and produce the specified quality of work. Do not use equipment that damages the roadway, adjacent property, or other highways.

Operate all equipment with adequate lighting at night.

Do not use methods or equipment other than as specified unless requested in writing and authorized by the Engineer. Include in the request a full description of the proposed methods and equipment to be used and the reasons for the change. Produce work meeting the contract requirements.

Discontinue use of alternate methods or equipment if the Engineer determines that the work does not meet contract requirements. Remove and replace or repair deficient work with work of specified quality at Contractor expense. No change will be made regarding payment for authorizing a change in methods or equipment.

108.07 DETERMINATION OF COMPENSATION AND EXTENSION OF CONTRACT TIME FOR EXCUSABLE, NONCOMPENSABLE AND COMPENSABLE DELAYS. Time allowed for completion of the Contract is determined by either the "Calendar Date" or the "Working Day" provision in the Contract.

108.07.1 Calendar Date Contracts. Complete all work by the fixed calendar date specified in the Contract. The fixed calendar completion date will be extended:

A. If the Contract is awarded more than 10 calendar days after bid opening;

B. For extra work according to the calendar days computed under Subsection 108.07.4;

C. For authorized suspensions of work.

The new completion date is determined by adding the number of calendar days between the tenth day after bid opening and the award date; the calendar days computed under Subsection 108.07.4; or the number of calendar days during authorized suspensions to the specified fixed calendar completion date.

The actual completion date is the date the Engineer accepts the project as complete under Subsection 105.15.2.

Contract time overruns for assessment of liquidated damages will be computed as the number of calendar days elapsing between the contract completion date and the actual completion date.

108.07.2 Working Day Contracts. Complete all work within the number of working days specified in the Contract.

A working day is defined in Subsection 101.82. Holidays designated as nonworking days are defined in Subsection 101.36.

Working days will be assessed against the contract time except for days when inclement weather or the aftermath of inclement weather prevents the performance of operations that would be in progress for at least 60% of the normal daily schedule being worked.

Assessment of time begins on the effective date of the Notice to Proceed.

If work cannot be performed at the regular starting time because of inclement weather or the effects of inclement weather and the work crew is dismissed, no time will be charged for that day.

Do not work on holidays or Sundays without the Engineer's approval. Work done on Saturdays, Sundays, and approved holidays will be assessed as working days (except during the period November 16 through April 15 when no time is charged for any work).

Producing and stockpiling surfacing aggregates, pre-wetting, making emergency repairs to the project, and providing protection for the public may be accomplished on Saturdays, Sundays, holidays, and during a work suspension period without assessment of time with the following exception:

The period between November 15 through April 15 is chargeable for State Maintenance Stockpiling Projects.

Assessment of time for all working days begins on the effective date of the Notice to Proceed. Inclement weather and its after effects will be treated the same as provided for above.

Chargeable or nonchargeable working days will be determined and agreed upon daily between the Project Manager and the Contractor's superintendent. Except for the period November 16 through April 15, the Project Manager will furnish a weekly report showing the number of working days:

A. Charged for the preceding week;

B. Previously charged;

C. Specified for contract completion;

D. Of approved time extensions, except for days covered under Subsection 108.07.4, second paragraph; and

E. Remaining to complete the Contract.

The report will be furnished every Monday. File a written protest with the Project Manager within ten calendar days of receipt of the weekly report of any alleged discrepancies in the time assessed. Failure to file a protest is conclusive evidence that the time assessed is accepted as correct.

108.07.3 Delays. The following delays will be considered for extensions of contract time.

A. Excusable or Noncompensable Delay. Contract time allowed for the performance of the work may be extended for delays caused by acts of God, acts of the public enemy, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes, unusually severe weather, or delays not caused by the Contractor's fault or negligence.

B. Compensable Delay. Contract time may be extended for delays caused by the Department under Subsection 108.07.5.

108.07.4 Extensions. Provide a written request to the Project Manager detailing the reasons for requesting a time extension. A plea that insufficient contract time was specified is not a valid reason for a time extension. If the Department finds that the work was delayed because of conditions beyond the control of and not the fault of the Contractor, the contract time will be extended in the amount justified. The extended time for completion will then be in full force and effect as though it were the original time for completion.

The contract time as awarded is based on the estimated quantities as defined in Subsection 102.05. No decrease in contract time will be made for any decrease in a contract item. The contract time will be increased based on the quantity and difficulty of added work. The minimum time allowed for any additional work is computed by the following formula:

$$\text{Time Extension in Days} = \frac{\text{Total Dollar Amount of Additional Work}}{\text{Total Amount of Contract as Awarded}} \times \text{The Contract Time as Awarded}$$

The computed time extension will be rounded to the nearest whole day.
No additional contract time will be allowed for:

A. Increases in percentages of asphalt in plant mix materials;

B. The addition of anti-stripping additives to bituminous materials;

C. The addition of or for increases in hydrated lime or mineral fillers to plant mix materials;

D. Increases in traffic control devices;

E. Delays for slow delivery of materials from the supplier or fabricator;

F. Material deliveries delayed for reasons of late ordering, financial considerations, or other foreseeable and preventable causes within the Contractor's control.

Delays in material deliveries for unusual market condition caused by an industry-wide strike, national disaster, or an area-wide shortage beyond the Contractor's control will be considered as a basis for granting additional time.

Submit written documentation substantiating the reasons for the late delivery or non-availability of materials to the Project Manager. The documentation must be from the original supplier and document the dates the material was ordered by the Contractor and the reason for late delivery or non-availability of the material. Include a statement elaborating on the efforts to obtain materials from alternate suppliers.

108.07.5 Delay Compensation. Notify the Project Manager of the request for delay consideration. Keep daily records of all non-salaried labor, material costs, and equipment expenses for all operations affected by the delay.

Maintain a daily record of each operation affected by the delay and the location, by stations, of the affected operations. The Department will maintain daily records of the operations by stations. Each Monday, the two records will be compared. Prepare and submit, each Monday, written reports to the Project Manager containing the following information:

1. Number of days behind schedule;
2. A summation of all operations that have been delayed, or will be delayed;
3. An explanation for compensable delays and how the Department's act or omission delayed each operation;
4. An estimate of the time required to complete the project;
5. An itemization of all extra costs incurred, including:
   a. Relating the extra costs to the delay and document how they are calculated and measured;
   b. Identifying all non-salaried project employees for whom costs are being compiled; and
   c. Summarizing the time charges for equipment, identified by manufacturer's number for which costs are compiled.

Provide the Project Manager a written summation of the comparison of the detailed reports within ten calendar days. Define all disagreements between specific records.

Failure to meet to review the Department's records or to report disagreements between the records is considered the Contractor's acceptance of the records as accurate.

A. **Procedures Following Completion of Work Allegedly Delayed.** Submit a written report to the Project Manager within 15 calendar days of project completion, or phase of work allegedly delayed, containing the following information:
   1. A description of the operations delayed and the documentation and explanation of the reason for the delay, including all reports prepared for the Contractor by consultants, if used; and
   2. An item by item measurement and explanation of extra costs requested for reimbursement due to the delay.

All costs shown in the report submitted to the Department must be certified by an accountant.

The Engineer will review the submittal and any reports prepared by the Project Manager. The Engineer will provide a written decision to the Contractor within 60 calendar days of receiving the submittal.

In the case of compensable delays, if it is determined that the Department is responsible for delays to the Contractor's operations, the Engineer's written decision

will reflect the nature and extent of any equitable adjustment to the contract as specified in Subsection 109.04.3.

108.08 FAILURE TO COMPLETE ON TIME. For each working day or calendar day the Contract remains uncompleted after the specified contract completion time, including approved adjustments, a daily charge will be made against the Contract. This daily charge, determined from Table 108-1 will be deducted from any money due the Contractor. This deduction is for liquidated damages for added Department contract administration costs for failure to complete the work on time.

TABLE 108-1
SCHEDULE OF LIQUIDATED DAMAGES

ORIGINAL CONTRACT AMOUNT		DAILY CHARGE	
From More Than	To and Including	Calendar Day or Fixed Date	Working Day
$ 0	$ 25,000	$ 136	$ 191
25,000	50,000	229	321
50,000	100,000	320	448
100,000	500,000	617	864
500,000	1,000,000	952	1334
1,000,000	2,000,000	1326	1856
2,000,000	5,000,000	1894	2652
5,000,000	10,000,000	2317	3244
10,000,000	—	2443	3421

Permitting the Contractor to continue and complete the work after the specified contract completion time or approved extensions granted does not waive the Department's rights under the Contract.

The Commission may waive such portions of the liquidated damages as may accrue after the work is in condition for the safe and convenient use by the traveling public.

108.09 DEFAULT OF CONTRACTOR. If the Contractor:

A. Fails to begin the work under the Contract within the time specified in the notice to proceed;

B. Fails to perform the work with sufficient resources to assure the prompt completion of the work;

C. Fails to perform the work in accordance with the contract requirements or refuses to remove and replace rejected materials or unacceptable work;

D. Discontinues the prosecution of the work;

E. Fails to resume work that has been discontinued within a reasonable time after notice to resume has been given;
F. Becomes insolvent or is declared bankrupt or commits an act of bankruptcy or insolvency;
G. Allows a final judgement to remain unsatisfied for a period of 10 days;
H. Makes an assignment for the benefit of creditors;
I. Fails to comply with contract requirements regarding minimum wage payments, EEO requirements, or any state or federally mandated affirmative action requirements;
J. For any other cause fails to carry on the work in an acceptable manner.

The Engineer will give written notice to the Contractor and surety of such delay, neglect, or default. Failure to correct the delay, neglect, or default within 10 calendar days after the Engineer's written notice gives the Department full authority without violating the Contract to take over prosecution of the work from the Contractor. The Department may appropriate or use any or all materials and equipment at the project site that is suitable and acceptable and enter into an agreement for completing the Contract. The Department may use any methods determined necessary to complete the Contract.

All costs and charges incurred by the Department, including the cost of completing the work under the Contract, will be deducted from any monies due or that may become due the Contractor. If the expense exceeds the sum that would have been payable under the Contract, then the Contractor and the surety shall be liable and shall pay to the Department the amount of such excess.

108.10 TERMINATION FOR PUBLIC CONVENIENCE.

108.10.1 General. The Department may terminate the Contract in whole or part, whenever:

A. Work cannot proceed because of an Executive Order of the President with respect to the prosecution of war or in the interest of national defense; or an Executive Order of the President or Governor of the State with respect to the preservation of energy resources; or
B. Work cannot proceed because of a preliminary, special, or permanent restraining order of a court of competent jurisdiction where the issuance of such restraining order is primarily caused by acts or omissions of persons or agencies other than the Contractor; or
C. It is determined that termination is in the best interests of the Department.

108.10.2 Payment. Payment will be made for the actual work performed at the contract unit prices for completed items of work when the Contract is terminated under Subsection 108.10.1.

An equitable adjustment for partially completed items of work and disposal of materials will be made under Subsection 109.05.

Submit to the Engineer a claim for termination costs after receipt of the notice of Termination for Public Convenience, under Subsection 108.10.1 (A). Detail the claim as specified in Subsection 105.16.2 so the Engineer can determine the basis and amount of the claim. Submit the claim no later than 60 calendar days from the effective date of termination. Resolution of the claim will be through the established

administrative channels. If the claim cannot be resolved and an agreement reached, appeal the claim under Subsection 105.16.3. Make all records available to verify the claim.

108.10.3 Responsibility of the Contractor and Surety. Termination of a contract does not relieve the Contractor of any contractual responsibilities for work nor the Surety or Sureties of the obligations under the contract bond or retainage bond for the work performed.

SECTION 109
MEASUREMENT AND PAYMENT

109.01 MEASUREMENT OF QUANTITIES. Work completed under the Contract will be measured using the United States standard measure or the metric system when specified.

Where the standard measure is given in the English system, approximate metric equivalents are shown in parentheses. No guarantee is provided, explicit or implicit, that the units are exact conversions. Work will be accepted on the basis of measures in the Contract. Specified metric tolerances apply to metric Contracts.

The method of measurement and computations used in determining quantities of material furnished and work performed are those methods recognized as conforming to sound engineering practice.

A station, when used as term of measurement, will be 100 linear feet or 100 meters.

Longitudinal and transverse measurements for surface area computations will be made horizontally using the neat plan dimensions. No deductions will be made for individual fixtures having an area of 9 square feet (0.8 m^2) or less.

Structures are measured using neat lines shown on the plans or as altered to fit field conditions.

Items that are measured by the linear foot (meter, millimeter), such as pipe culverts, guardrail, underdrains, and the like, are measured parallel to the structure base or foundation.

The average end area method is used for computing excavation volumes.

The term "gage," when used for measuring plates, is the U.S. Standard Gage. Galvanized sheets used in the manufacture of corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing are specified and measured as sheet thickness in inches (millimeters).

When the term "gage" refers to measuring wire, it is the U.S. Steel Wire Gage.

The term "ton" is the short ton consisting of 2,000 pounds avoirdupois (908 kg).

Measure or proportion weighed materials on certified scales at the designated locations.

Material shipped by rail may be accepted using the car weight provided that only the actual weight of material is paid for. Car weights are not acceptable for material that will be processed in mixing plants.

Obtain tare weights daily on haul vehicles, or as directed. Clearly mark each individual vehicle with a legible identification mark.

Haul materials measured by volume in approved hauling vehicles and measure materials at the point of delivery.

If approved, material specified to be measured by the ton may be weighed and converted to cubic yards (cubic meters). The Project Manager will determine the conversion factors from weight to volume subject to Contractor concurrence before using this method of measurement.

Bituminous materials are measured by the gallon or ton (liter or metric ton). Volumes are measured at 60 °F (15.5 °C) or will be corrected to the volume at 60 °F (15.5 °C) under ASTM D 1250.

Net certified scale weights, based on certified volumes in the case of rail shipments, will be the basis of measurement, corrected for loss of bituminous

material from the car or distributor, wasted, or otherwise not incorporated in the work.

When bituminous materials are shipped by truck or transport, net certified weights or volume, subject to correction for loss or foaming, may be used for computing quantities.

Cement is measured by the short ton (metric ton). A short ton is 2,000 pounds (908 kg).

Timber is measured by the thousand feet board measure (MFBM) (cubic meter) for timber actually incorporated in the structure. Measurement is based on nominal widths and thicknesses and each pieces extreme length.

"Lump sum" payment is complete payment for the work item described in the Contract.

When a complete structure or structural unit (i.e., "lump sum" work) is specified as the unit of measurement, the unit includes all necessary fittings and accessories.

Rented equipment is measured in hours of actual working time and necessary equipment travel time within the project limits. Travel time and transportation to the project is measured for special equipment, ordered by the Project Manager for force account work.

When standard manufactured items are specified, such as fence, wire, plates, rolled shapes, pipe conduit, etc., and these items are identified by gage, unit weight, section dimensions, etc., this identification is the nominal weight or dimension. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerances established by the industries involved will be accepted.

Other quantities are computed in the contract units using established engineering principles, without consideration of local rules or customs.

109.01.1 Weighing Equipment. Furnish accurate weigh equipment for material specified to be proportioned or measured for payment by weight. The weigh equipment must indicate the weight to within the smaller of :

1. Tolerances from correct weight adopted by the Montana Bureau of Weights and Measures; or
2. .05 % of the correct weight.

Use weigh systems tested and certified by the Bureau of Weights and Measures before each use and after each scale set-up or when directed. The Project Manager will accept reports from a Montana certified scale service stating compliance with the applicable tolerances in lieu of State certification. Seal the weigh system after adjustment and testing. Evidence of tampering or scale adjustment is cause to suspend use of the scale until it is re-tested and certified.

All materials received after the last test and certification will be reduced by the percent of error in excess of the specified tolerances if the weigh system is found to overweigh (indicate more than the correct weight).

No adjustment is made for systems found to under-weigh (indicate less than the correct weight).

Repair and re-certify weigh systems under-weighing or over-weighing outside the specified accuracy limits before use.

Follow the weigh equipment manufacturers procedures or the National Bureau of Standards Handbook No. 44 procedures for weigh system testing, witnessed by

the Project Manager. Provide all equipment, tools, and labor necessary to perform the test. Test permanent scales at least annually.

The cost of furnishing, testing, operating and maintaining weigh equipment is incidental to and included in the payment for the work.

109.02 SCOPE OF PAYMENT. Receive and accept the specified compensation as full payment for furnishing all materials, performing all work under the Contract in a complete and acceptable manner and for all risk, loss, damage, or expense arising from the work, subject to Subsection 107.21.

If the "Basis of Payment" clause for unit price in the Contract requires that the unit price be full compensation for work or material essential to the item, this same work or material is not measured or paid for under any other pay item in the Contract.

The payment of any current or final estimate or of any retained percentage does not prejudice or affect the Contractor's obligation to submit for final acceptance a completed improvement meeting the Contract specifications.

In accordance with the requirements of Chapter 50, Title 15, MCA, for contracts exceeding $5,000, including approved modifications, the Department will withhold 1 percent of the dollar amount of all Contractor payments. All payments by a prime contractor to a subcontractor are also subject to this 1 percent gross receipts fee. The prime contractor must withhold 1 percent of all payments made to subcontractors.

109.03 COMPENSATION FOR ALTERED QUANTITIES. Accept payment for work quantities which vary from the Contract quantities at the original contract unit prices. No allowance, except under Subsections 104.02 and 108.10, will be made for any increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed resulting either directly from such alterations or indirectly from unbalanced allocation among the contract items of overhead expense and subsequent loss of expected reimbursements or from any other cause.

Only those quantities of materials actually incorporated into the final work and accepted will be paid.

109.04 PAYMENT FOR EXTRA WORK. Payment for extra work is made under one of the following:

109.04.1 Unit Price or Lump Sum Basis. Extra work performed under Subsections 104.02 and 104.03 is paid for at the unit price or lump sum price agreed upon and specified in the authorized work order. Extra work is authorized by a change order signed by both parties.

109.04.2 Force Account Basis. Approved extra work paid for on a force account basis must be accounted for daily on report sheets signed by each parties authorized representative. The daily report sheets are the true record of extra work. Extra work on a force account basis ordered by the Engineer in writing, under Section 104, is paid for as follows:

A. Labor. The Contractor is paid the wage rates for all labor and foremen performing the extra work for the total hours worked plus at least 80 percent

of the total. The 80 percent surcharge may be increased if certified documentation is submitted showing that a higher percentage surcharge is needed to cover labor costs. The wage rates used for the above computation includes travel pay, if applicable, but must not include fringe benefits, whether or not paid directly to the employees. Payment as described above is full compensation for all labor related expenses incurred including but not limited to premiums for worker's compensation insurance, public liability and property damage insurance, social security, unemployment compensation, health and welfare expenses, and other expenses imposed by federal or state laws or both.

Submit evidence of the actual wage rates paid.

B. Materials. The Contractor will receive the actual delivered cost of all materials used based on invoices, plus 15 percent. The quantity of material used must be documented.

C. Equipment. The Contractor will receive the rental rates agreed upon in writing before beginning the work for any machinery or special equipment (other than small tools) used to perform the work. Rental rates are calculated using the current issue of the Departments Equipment Rental Rate Guidelines. Rates and allowances for standby time, outside rented equipment, owner-operated equipment, and moving of equipment is determined under the Equipment Rate Guidelines.

D. Bond. The actual cost chargeable to force account work of premiums for the performance bond are paid. No surcharge is allowed for the performance bond. Furnish evidence of the rate paid for the bond.

E. Miscellaneous. Accept the compensation provided for under Subsection 109.09.2 as full payment for extra work done.

F. Statements. Submit all statements for the extra work done on a force account basis on Department forms. Attach the original extra work order, material invoices and freight bills.

The Inspector will compile and forward to the Project Manager, at the end of each day, a daily record of extra work done on a force account basis, signed by both the Inspector and Contractor's Superintendent.

G. Subcontracting. Extra work performed on a force account basis by a subcontractor under a extra work order will include the percentage allowed in Table 109-1 for administrative expenses. This administrative allowance only applies to charges for labor and materials. The allowance is applied to all charges and added percentages specified in paragraphs (A), (B), and (D) above. Bid items in the original contract are not eligible for this administrative allowance.

TABLE 109-1

SUBCONTRACTING - ADMINISTRATIVE ALLOWANCES	
$0 to $1,000	10%
$1,000.01 to $10,000	$100 plus 5% of excess over $1,000
Over $10,000.01	$550 plus 3% of excess over $10,000

Approval of this additional percentage is made after the Contractor furnishes receipted invoices.

Administrative expenses are not paid on a force account basis above the amount allowed the prime and subcontractor if the work is done by a sub subcontractor.

109.04.3 Equitable Adjustment. The equitable adjustment provided for in Subsection 105.16 is determined as follows:

A. If the parties agree, the price is determined using unit prices or other agreed upon prices.

B. If the parties cannot agree, the price is determined by the Engineer using unit prices or other means to establish cost.

The following limitations apply:

A. The rental rates must be actual cost not to exceed the rates established in Subsection 109.04.2 and in effect at the time the work is performed.

B. No claim for loss of anticipated profits on deleted or uncompleted work or consequential damages of any kind is allowed.

109.05 DELETED OR TERMINATED WORK. The Engineer may delete work by change order under Subsection 104.02.4 or may terminate the contract in whole or part, under Subsection 108.10. When the contract is terminated in part, the partial termination shall be treated as a deletion change order for payment under this Section. Payment for completed items will be at the unit contract prices.

When any item is deleted, in whole or in part, by change order or when the contract is terminated, in whole or in part, payment for deleted or terminated work is made as follows:

1. Payment will be made for the actual number of units of work completed at the unit contract prices unless the Engineer determines the unit prices are inappropriate for the work actually performed. When that determination is made, payment for work performed will be as mutually agreed. If the parties cannot agree, the Engineer will determine the amount or the equitable adjustment under Subsection 109.04.3;
2. Payment for partially completed lump sum items will be as mutually agreed. If the parties cannot agree, the Engineer will determine the amount of the equitable adjustment under Subsection 109.04.3;
3. The Department will pay as part of the equitable adjustment those direct costs necessarily and actually incurred in anticipation of performing the work that has been deleted or terminated. Costs previously paid for by the contract prices for completed units of work are excluded;
4. The total payment for any one item in the case of a deletion or partial termination shall not exceed the bid price as modified by approved change orders less the estimated cost (including overhead and profit) to complete the work and less any amount paid to the Contractor for the item;
5. The total payment where the contract is terminated will not exceed the total contract price, as modified by approved change orders less those amounts paid before the effective date of termination;

6. No claim for damages of any kind or for loss of anticipated profits on deleted or terminated work will be allowed because of the termination or change order.

Contract time will be adjusted as the parties agree. If the parties cannot agree, the Engineer will determine the equitable adjustment for contract time.

Materials to be permanently incorporated into the work and ordered before the date the work was terminated under Subsection 108.10 or as deleted under Subsection 104.02, will either be purchased by the Department at the actual cost and become Department property, or the Contractor will be reimbursed for the actual cost of returning the materials to the suppliers.

109.06 PARTIAL PAYMENTS. Partial payments will be made once each month based on estimates of the value of the work performed and materials complete in place under the Contract, including materials delivered under Subsection 109.07.

The Department reserves the right to withhold all or part of any partial payments earned under the Contract until all special fuel user's tax payments due or owing to the State of Montana under 15-70-302 MCA or other statutory taxes are paid in full.

The Department will not withhold any retainage on the first 80 percent of the contract awarded amount, if the Contractor does not become delinquent in any contractual obligations and progress is satisfactory.

After 80 percent of the Contract has been completed, 10 percent of each monthly progress estimate will be retained until 5 percent of the final 20 percent of the value of the contract awarded amount is retained.

If the Contractor becomes delinquent in any contractual obligations, the retained amount will be computed at 10 percent of each monthly estimate.

If the Contract extends beyond the Contract completion time, the sum specified in Table 108-1 will be deducted from any money due the Contractor.

109.07 PAYMENT FOR MATERIAL ON HAND. The materials designated in Table 109-2, when produced or delivered and stockpiled at the project site or other approved location near the project site may be considered for partial payment, if the following requirements are met:

1. The material meets the Contract requirements;
2. The material is a manufactured end product or a fully fabricated product. Aggregate must be produced and stockpiled to the final stage for incorporation into the specified mixture or the roadway;
3. Material is stored to prevent damage and theft, without obstructing or impeding the traveling public;
4. A written request accompanied by a delivery receipt for all items received. Include the quantity for which payment is requested and the length of time the material is to be stored;
5. Furnish paid invoices for all stored manufactured or fabricated materials that have not been incorporated into the permanent work within 60 days from the date payment was requested. Include a notarized statement from the supplier or fabricator certifying that their payment has been received. If a paid invoice is not furnished, the quantity of any previously allowed material remaining in storage will be deducted from the next progress

estimate, and further payment will not be made until the material is incorporated into the work.

If stored material is lost, stolen, or damaged, the materials value will be deducted from the subsequent estimate or estimates.

Payment of partial estimates for stored material, acceptance of the materials to be stored, or approval of the storage method does not relieve the Contractor's responsibility for all materials and work upon which payments have been made or the restoration of any damaged work. The payments are not a waiver by the Department of any other Contract provisions or of its rights to require fulfillment of all Contract terms.

Partial payment will be made at the contract unit price for the specified percentage of the quantity produced or delivered and stockpiled as follows:

TABLE 109-2
MATERIALS IN STORAGE ELIGIBLE FOR PAYMENT

MATERIAL	PERCENT OF QUANTITY FOR PARTIAL PAYMENT
Aggregate Base and Surfacing	
0-5 Miles Haul (0-8 km)	50
6-9 Miles Haul (10-15 km)	60
10-20 Miles Haul (16-32 km)	63
21 Miles and Greater (34 km)	65
Cover Material & OGFC	50
Aggregate for Bituminous Mixtures	
0-5 Miles Haul (0-8 km)	35
6-9 Miles Haul (10-15 km)	45
10-19 Miles Haul (16-31 km)	48
20-29 Miles Haul (32-47 km)	51
30-39 Miles Haul (48-63 km)	54
41 Miles and Greater (66 km)	57
Aggregate for Concrete (Bridges)	2
Aggregate for Concrete (PCCP)	8
Structural Steel	60
Reinforcing Steel	50
Corrugated Metal Pipe	40
Structural Plate Pipe or Pipe Arch	50

MATERIAL	PERCENT OF QUANTITY FOR PARTIAL PAYMENT
Concrete Pipe	50
Guardrail (Rail and Hardware)	25
Guardrail (Posts and Blocks)	30
Fencing (Posts and Wire)	30
Precast Concrete Bridge Members (after curing period is completed)	60
Cantilever and Bridge Sign Structures	50
Sign Panels	60
Electrical and Signal Items	50
Steel Sign Posts	35
Wood Sign Posts	35
Posts, Metal U	40
Precast Concrete Products	50
Cattleguards	50
Topsoil	30
Water and Sewer Pipe and Appurtenances	40
Construction Fabric	50
Striping - Preformed Plastic	65
Words and Symbols - Preformed Plastic	75
Thermoplastic Pavement Marking Material	40
Treated Timber	50

Haul is the distance to the nearest mile (km) via the most direct route from the aggregate production plant to the stockpiles for mix production as determined by the Project Manager.

Payment will be made for aggregates which will be stockpiled for at least 60 days or at the Engineer's discretion.

109.08 ACCEPTANCE AND FINAL PAYMENT. When the project is accepted under Subsection 105.15, a final estimate will be prepared. The estimate will include the amount and value of each class of work performed and any extra work and materials. Deductions for all previous payments and amounts to be deducted or retained under the provisions of the contract will be made in the final estimate. Errors made in previous partial payments will be corrected in the final estimate.

The final estimate will be submitted to the Contractor for approval. Once approved, the entire sum due will be paid.

The Department reserves the right to withhold all or part of the final payments earned under the contract until all taxes and assessments due and owing to the State of Montana for any reason have been paid in full unless a written release is received from the Department or the state agency having a claim against the Contractor.

The statutory time for filing claims against the contract bond is 90 calendar days and shall date from the day of final acceptance of the project by the Commission. See 18-2-201 to 18-2-208, MCA.

The Engineer will immediately notify the Contractor and its surety of all claims filed against the contract or bond.

109.09 MOBILIZATION.

109.09.1 General. Mobilization is the preparatory work and operations performed including, but not limited to, those necessary for:

1. The movement of personnel, equipment, supplies, and incidentals to the project site;
2. The establishment of all offices, buildings, and other facilities necessary for work on the project;
3. Premium on contract bonds;
4. Insurance for the Contract;
5. Other work and operations that must be performed or costs incurred before beginning contract work;
6. Mobilization costs for subcontracted work.

109.09.2 Payment. The original contract amount is the total price of the Contract as bid and includes mobilization. Partial payments for mobilization will be made monthly based on the lump sum contract price as follows:

1. One percent of the original contract amount, but not more than 100% of the amount bid for mobilization, will be paid on the first regular estimate period following the award of the Contract;
2. When 5% of the original contract amount is paid under the Contract, 25% of the amount bid for mobilization or 3% of the original contract amount, whichever is less, will be paid;
3. When 10% of the original contract amount is paid under the Contract, 50% of the amount bid for mobilization or 6% of the original contract amount, whichever is less, will be paid;
4. When 25% of the original contract amount is paid under the Contract, 60% of the amount bid for mobilization or 8% of the original contract amount, whichever is less, will be paid;
5. When 50% of the original contract amount is paid under the Contract, 90% of the amount bid for mobilization or 10% of the original contract amount, whichever is less, will be paid;
6. When 70% of the original contract amount is paid under the Contract, 100% of the amount bid for mobilization will be paid.

Nothing in the Contract shall be construed to limit or preclude partial payments provided in the Contract. Payment will be full compensation for all work necessary to complete the item.

109.09.3 Payment (SMP Contracts). An exception to Subsection 109.09.2 is:

For state maintenance stockpile contracts (SMP contracts), mobilization will be paid for based on the percentage each stockpile site quantity bears in relation to the entire contract quantity, determined by the Department. The amount established as payment for mobilization for each site will be paid in its entirety with the first estimate for each site.

109.10 OVERPAYMENTS. Overpayments on progress estimates will be deducted from subsequent progress estimate payments, or the Contractor may be notified of the overpayment. The Contractor will have 60 days from the date of receipt of notification of overpayment to repay the money owed. If the money owed is not received by the Department before the 60-day period expires, interest will be charged on the overpayment beginning with the date of receipt of notification of overpayment. The interest rate charged will be the average Short Term Investment Pool (STIP) rate, determined by the Montana State Board of Investments, for the period in which the overpayment is not repaid.

SECTION 201
CLEARING AND GRUBBING

201.01 DESCRIPTION. This work is the clearing, grubbing, removing, burning, burying, and disposing of vegetation and debris within the right-of-way limits and easement areas without damaging vegetation, adjacent property and other objects designated to remain in place.

Immediately stop work and notify the Engineer if evidence of aboriginal activity or occupation is encountered.

201.01.1 Clearing. Clearing is felling trees, disposing of stumps, brush, windfalls, logs, limbs, sticks, piles of sawdust, rubbish, debris, vegetation, and other matter within the clearing limits or other areas that interfere with excavation and embankment limits.

201.01.2 Grubbing. Grubbing is removing and disposing of roots, stumps, stubs, duff, matted roots, and debris from the grubbing limits.

201.01.3 Clearing and Grubbing. Is performing both clearing and grubbing under Subsections 201.01.1 and 201.01.2.

201.01.4 Disposal. Disposal is removing, burning, and burying the accumulations from clearing, grubbing, or clearing and grubbing operations meeting all Local, State and Federal laws and regulations.

201.02 RESERVED.

201.03 CONSTRUCTION REQUIREMENTS.

201.03.1 General. Limit dragging, piling, disposing of debris, and other work to areas to be excavated or covered by embankments. Do not damage or destroy vegetation not designated to be removed.

Do not injure or damage vegetation adjacent to streams, ponds, or lakes unless designated for removal in the Contract. Replace damaged or destroyed vegetation designated to be preserved at Contractor expense.

Coat cut or scarred surfaces of trees or shrubs to be preserved with a asphaltum base paint formulated for tree surgery.

Locate pioneer roads or work trails a minimum 20 feet (6.0 m) inside of the clearing limits. Protect live root systems adjacent to, but outside of, the clearing limits.

Close-cut and remove potential hazards, such as leaning trees (alive or dead), and snags within the right-of-way as designated by the Project Manager.

Coordinate clearing, grubbing, or clearing and grubbing with the grading work to meet the requirements of the approved erosion control plan in Subsection 208.03.2. Backfill or grade depressions caused by grubbing to drain. Construct temporary settling basins where scour may occur.

The Project Manager will stake the construction limits for cuts, fills, channel changes, ditches, fence lines, utility relocation, roadside development areas,

selective thinning for sight distance, grubbing, and similar areas to establish clearing and grubbing limits.

201.03.2 Clearing. Clear only within the staked construction limits.

Cut off trees, stumps, brush, shrubs, and other vegetation to within 6-inches (155 mm) of the ground. Fell trees without endangering traffic and injuring trees or objects not designated for removal.

Remove dead vegetation, logs, stumps, limbs, sticks, sawdust piles, rubbish, debris, and other undesirable matter from areas where live shrubbery, brush, or trees are to remain in place.

Merchantable timber is the property of the Contractor.

201.03.3 Grubbing. Grub only within the staked construction limits.

Remove all stumps, roots, logs, timber more than 3-inches (75 mm) in diameter, and all brush, matted roots, and other debris within the grubbing limits to at least 12-inches (305 mm) below the original ground surface.

Grubbing items that do not extend more than 6-inches (155 mm) above the ground line that will be covered with a minimum 4 feet (1.2 m) of subgrade or slope embankment may remain.

201.03.4 Clearing and Grubbing. Clear and grub meeting the requirements of Subsections 201.03.2 and 201.03.3.

201.03.5 Disposal. Dispose of all brush, stumps, windfalls, slash, timber having no commercial value, and all other debris from clearing, grubbing, clearing and grubbing, or other operations to meet all Local, State and Federal requirements at Contractor expense.

A. Burning. Burn materials meeting the State of Montana Open Burning Regulations administered by the Air Quality Bureau of the Montana Department of Health and Environmental Sciences, and all other applicable Local, State and Federal rules and regulations. The general requirements of the Montana Open Burning Regulations regarding burning season and permits are described below.

1. **Permits.** Obtain an open burning permit from the Air Quality Bureau during the open burning season when burning more than 100 acres (40.5 ha) of forest residue per year.

   When burning near public lands during the fire season (May 1 through September 30, or as extended), obtain a burning permit from the Local, State or Federal fire protection agency having jurisdiction.
2. **Open Burning Season.** The open burning season for forestry slash is from March 1 through November 30. Open burning is not allowed during December, January, or February. Burning from September 1 through November 30, on a day to day basis is subject to ventilation conditions available from the Air Quality Bureau, at 1-800-225-6779. Obtain the ventilation conditions daily before burning.
3. **Burning Methods and Instructions.** Burning by the Air Curtain Destructor or Forced Air methods are encouraged.

Obtain the Project Manager's approval for burning pits located within the right-of-way limits. Dispose of all pits, ashes, and debris meeting Subsection 201.03.5(B). Locate burning pits at least 100 feet (30.5 m) from free-flowing water or areas where ditches are to be constructed. Locate pits and incinerators to prevent any fire damage or hazard to surrounding vegetation or structures. Contact local fire protection agencies before the start of any burning.

Provide 24 hour monitoring of all burning.

B. Disposal of other Material. Obtain the Project Manager's approval to incorporate non-hazardous solid material into the work for constructive use.

Dispose of material not incorporated into the work at Contractor expense.

201.04 METHOD OF MEASUREMENT. Measurement for clearing, grubbing, or clearing and grubbing is by either of the following methods.

201.04.1 Lump Sum Basis. No measurement or area or quantity is made. Disposal of the material is not measured for payment.

201.04.2 Area Basis. Measurement is by the acre (hectare) for the area actually cleared, to the nearest 0.1 acre (0.04 ha) to the limits in the Contract or as staked by the Project Manager. Disposal is not measured for payment.

201.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Clearing	Lump Sum or Acre (hectare)
Grubbing	Lump Sum or Acre (hectare)
Clearing and Grubbing	Lump Sum or Acre (hectare)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

201.05.1 Lump Sum Basis. Payments will be prorated for the percentage of completed work for each item listed as a lump sum item in the Contract.

201.05.2 Area Basis. No payment is made or allowed for any areas not actually cleared (i.e. Present Traveled Way, Paved surfaces, etc.)

201.05.4 Exclusion. When the Contract does not contain a pay item for clearing, grubbing, or clearing and grubbing, the work is incidental to and included in payment for other work items.

SECTION 202
REMOVAL OF STRUCTURES AND OBSTRUCTIONS

202.01 DESCRIPTION. Remove and dispose of all structures and obstructions not designated to remain or to be removed and disposed of under other items of the Contract.

202.02 RESERVED.

202.03 CONSTRUCTION REQUIREMENTS. Raze, remove, and dispose of all buildings, foundations, structures, fences, debris, and other obstructions on the right-of-way, excluding utilities. Remove and transport specified salvage material designated to remain property of the Department, without damage, to the specified locations. Obtain the Project Manager's written permission to use any salvaged materials.

Dispose of unusable combustible material under Subsection 201.03.5(A). Dispose of unusable noncombustible material under Subsection 201.03.5(B). Backfill cavities caused by removing structures and obstructions level with the surrounding ground and compact the backfill under Subsection 203.03.3.

Install the necessary traffic control devices when removing and transporting structures to maintain traffic in the work area.

202.03.1 Removal of Bridges and Major Drainage Structures.

A. **Removal of Superstructures.** Repair or replace all damaged or destroyed members, pins, nuts, and plates from steel or timber structures designated to be salvaged at Contractor expense.

Match-mark all members to be salvaged with paint before dismantling. Similarly mark all pins, nuts, and plates to indicate their location in the structure. Paint all pins, pin holes, and machined surfaces with a zinc-rich paint, and wire all loose parts to adjacent members or pack in clearly marked boxes showing the contents and index-numbered for identification.

B. **Removal of Substructures.** Remove substructures above the ground surface to 3 feet (915 mm) below the finished ground surface. Remove or cut off piles and substructures 1 foot (305 mm) below the stream bed. Shape and contour removal areas to blend with the surrounding terrain.

Do not damage new work removing existing structures.

C. **Disposal of Materials Removed.**
   1. **Structural Steel.** Store salvaged structure members and all steel beams above the ground on skids at the designated sites.
   2. **Concrete and Masonry.** Use concrete and masonry removed from old structures in backfills or approach embankments under Section 203. Dispose of concrete or masonry not placed in backfills or embankments at Contractor expense. Remove all contract related concrete rubble from streams.
   3. **Timber and Other Materials.** Store all salvageable timber or other salvaged materials above ground on skids at the designated sites.

D. Disposal of Temporary Structures. Remove and dispose of all temporary structures under 202.03.1(C).

202.03.2 Removal of Pipe Culverts and Minor Drainage Structures. Remove and salvage pipe culverts and minor drainage structures as specified in the Contract. Replace lost or damaged salvaged material at Contractor expense.

202.03.3 Removal of Pavement, Sidewalks, Curbs, Etc. Remove and dispose of all concrete pavement, base course, sidewalks, curbs, gutters, etc. under Subsection 202.03.1(C)(2).

Dispose of ballast, gravel, bituminous material, and other surfacing and paving materials under Subsection 201.03.5(B).

202.04 METHOD OF MEASUREMENT.

202.04.1 General. Measurement on a lump sum or an individual unit includes the removal and disposal of all structures and obstructions encountered within the right-of-way.

202.04.2 Pipe Culvert Removal or Remove and Relay. The pipe length is measured in linear feet (meter) to the nearest foot (305 mm), in place before removal.

202.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Remove Structures and Obstructions	Lump Sum or Each
Remove Pipe Culvert	Lineal Foot (meter)
Remove and Relay Pipe Culvert	Lineal Foot (meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

When the Contract does not contain estimated quantities or lump sum items for removal and disposal of structures and obstructions, the work is not paid for directly and is incidental to other items of work.

SECTION 203
EXCAVATION AND EMBANKMENT

203.01 DESCRIPTION. This work is the excavation, placing, compacting and disposal of material encountered within the construction limits necessary to construct the project.

203.01.1 Excavation.

A. Unclassified Excavation. Unclassified excavation is excavating and disposing, when required, of material from the right-of-way or construction easement areas except borrow excavation and muck excavation as defined in Subsections 203.01.1 (B) and (E).

B. Borrow Excavation.

1. Unclassified Borrow. Unclassified borrow for embankment construction is Contractor furnished excavation from outside the right-of-way or construction easement areas.

Use Department approved sources meeting current environmental and cultural resource preservation regulations.

Material from a Department-optioned or Department-owned borrow source may be available at no cost. For contractor-furnished sources, the haul distance is measured for payment under Subsection 206.04.

The applicable provisions of Subsections 102.06 and 106.02 apply to unclassified borrow.

2. Special Borrow. Special borrow is excavation from designated sources or from other approved sources.

Subsection 203.01.1(B)(1) and the applicable provisions of Subsection 106.02 apply to special borrow.

C. Unclassified Channel Excavation. Unclassified channel excavation is excavating and disposing of all materials from new water courses or channels and the widening, deepening, or straightening of existing channels.

D. Street Excavation. Street excavation is excavating all material to the street template.

E. Muck Excavation. Muck excavation is removing and disposing of unstable material below subgrade elevation in cut sections or below the natural ground line in embankment sections.

Material is considered unstable if:

1. It contains saturated or unsaturated mixtures of soils and organic matter unsuitable for foundation material, regardless of moisture content; and

2. If it cannot be excavated using the same equipment and methods as for unclassified excavation.

If a grade line is adjusted, the difference between the staked or plan lines and adjusted grade lines is not muck excavation unless unstable material is encountered at or below the final grade line. Topsoil removed below the natural ground line in embankment sections is muck excavation

if the material is determined unstable and cannot be excavated using the same equipment and methods for unclassified excavation.

Excavated unstable material areas will be cross sectioned before they are backfilled.

Do not place fill over unstable foundation soils without the Project Manager's approval. Materials placed before approval may be ordered removed and replaced at Contractor expense.

F. **Sub-excavation.** Sub-excavation is removing unsuitable material from below the plan subgrade elevation as shown or directed.

203.01.2 Embankment. Place and compact excavation in roadway embankments, dikes, areas where unsuitable material is removed, holes, pits, and other roadway depressions. Prepare embankment foundations, obtain embankment material from the designated roadway, drainage, structure, culvert, or borrow excavation.

203.02 RESERVED.

203.03 CONSTRUCTION REQUIREMENTS.

203.03.1 Excavation.

A. **General.** Do not begin excavation, grading, and embankment operations before the area is cleared of vegetation and obstructions under Sections 201 and 202 and erosion controls are placed as specified in the Contract.

Excavate without disturbing material and vegetation outside of the slope limits.

Use all suitable material removed from the excavation in embankments, subgrade, shoulders, topsoiling, and other designated locations. Excavated material not used as specified or directed is not paid for.

Sequence excavation of backfill or road finishing material so it is placed into final position as soon as possible. Stockpile suitable material that is not immediately used.

Construct temporary fencing to restrict livestock and vehicular traffic from the work under Subsection 607.03.5.

Replace temporarily removed fence and repair damaged fence to a condition equal to the existing fence at Contractor expense. Confine livestock when fencing is disturbed.

If excavated material from the roadway prism is used outside the embankments, furnish and place at Contractor expense, an equal quantity of borrow to replace the material.

Compact the top 8-inches (205 mm) of the subgrade in cut sections under Subsection 203.03.3.

Place special borrow in layers immediately below the subgrade surface on embankments and through cuts as specified.

B. **Rock Blasting.**

1. **General.** Use and store explosives under Subsection 107.09.

Use current technology in rock blasting to prevent slides, minimize overbreak, and provide smooth cut slope faces free of loose or fractured rock. Design the ignition sequence and blasting pattern with

delays to produce maximum relief to the holes nearest the cut slope face.

Temporarily suspend blasting operations if the specified slopes are not produced, nearby residences, structures, utilities, or appurtenances are endangered, or the safety and convenience of the traveling public is jeopardized by fly rock, fragmentation, vibration, air blast, or overbreak.

2. **Blasting Plan.** Submit the blasting plan to the Project Manager at least two weeks before drilling and blasting operations begin and when there is a change in the proposed drilling and blasting methods. Submit the blasting plan on form CSN-55, available from the Project Manager, with the following information.
   - **a.** Station limits of proposed blast.
   - **b.** Plan of proposed drill hole and delay pattern including free face, burden, and spacing.
   - **c.** Report of hole depth, diameter, burden, spacing, stemming, explosive types, powder factor, and delays.

   The blasting plan is to reflect a blast design that provides for the proper drilling and blasting procedures to produce the specified results.

   Revise the drilling and blasting methods as necessary to produce the specified results.
3. **Scaling.** Scale all loose or detached rock and soil masses that create a potentially dangerous situation to the work, workers, or the public. Remove the rock by barring, wedging, equipment, or using light explosive charges. Scale during or after each lift is completed. Scaling and disposing of the scaled materials is incidental to unclassified excavation.
4. **Pre-splitting Rock Slopes.**
   - **a. General.** Pre-split rock cuts to a smooth plane using loaded, timed, and spaced drill holes. Produce a continuous or semi-continuous fracture between drill holes and a stable rock cut by eliminating overbreak in the backslope during primary blasting. Detonate pre-split holes before detonating the production holes.
   - **b. Drilling.** Use drills equipped with mechanical devices that accurately determine the angle the drill steel enters the rock. Do not drill if the devices are missing or inoperative.

     Remove overburden soil and loose or decomposed rock along the top of the excavation to produce a smooth rock surface for drilling.

     Use pre-split hole diameters that are between 2½-inches (64 mm) and 3-inches (75 mm). Drill pre-split holes within 3-inches (75 mm) of the staked collar location. Holes drilled outside the 3-inch (75 mm) tolerance will be rejected and not measured for payment. Drill hole intervals may vary between 24 (610 mm) and 36-inches (915 mm). A 30-inch (765 mm) interval is used to estimate the linear measurement of pre-split Contract quantities.

     When the cut height exceeds 30 feet (10 m), an offset from the staked slope line, not to exceed 2 feet (610 mm) is allowed at the

top of each lift after the top lift. The actual slope cannot deviate from the plan slope by more than 2 feet (610 mm).

Control the drilling operations to insure that no hole deviates from the slope plane by more than 9-inches (230 mm) parallel or normal to the slope. Pre-split holes exceeding these limits will not be paid for.

Drilling 2 feet (610 mm) below ditch bottom to aid removing the toe berm is permitted.

Extend pre-split holes a minimum of 30 feet (9.2 m) beyond the limits of the production holes or to the end of the cut.

Maintain the length of pre-split holes for any individual lift at no more than 30 feet (9.2 m). The Project Manager may approve a written request to increase the hole length to a maximum of 60 feet (18.3 m) if it is demonstrated that the above pre-split hole tolerances and a uniform slope can be obtained. If over 5% of the pre-split holes are misaligned in any one lift, reduce the lift heights until the 9-inch (230 mm) tolerance is met.

c. **Blasting.** Verify that the drill holes are free of obstructions for their entire depth before placing charges. Take precautions to prevent material from entering the drill holes while placing the charges.

Drill hole conditions may vary from dry to water filled. Use the type or types of explosives and blasting accessories for the conditions encountered following the manufacturer's recommendations.

Use explosives with a maximum diameter no more than one-half the diameter of the pre-split hole. Do not use bulk ammonium nitrate and fuel oil (ANFO) in the pre-split holes. Use only standard explosives manufactured specifically for pre-splitting.

If fractional portions of standard explosive cartridges are used, firmly affix them to the detonating cord to prevent the cartridges from slipping down the cord or bridging across the hole. Space fractional cartridges along the length of the detonating cord at maximum 30-inch (765 mm) centers and adjust spacing to produce the specified results.

Assemble and affix continuous column cartridge type explosives to the detonating cord following the explosive manufacturer's instructions. Furnish the Project Manager these instructions 24 hours before blasting begins.

The pre-split hole bottom charge may be larger than the line charges if it does not cause overbreak. Reduce the top charge of the pre-split hole and place it far enough below the collar to avoid overbreak and heaving.

Stem the upper 3 feet (915 mm) of all pre-split holes below the hole collar with sand or other dry, angular granular material passing a ⅜-inch (9.5 mm) sieve.

The Contractor may pre-split the slope face before production drilling or pre-split the slope face and production blast at the same time, if the pre-split drill holes are fired simultaneously at least 100

milliseconds before the production blast. Do not delay pre-split holes more than 25 milliseconds, hole to hole, to reduce noise and ground vibration.

Do not vary the pre-split slope face by more than 1 foot (305 mm), measured perpendicular to the slope, from a plane passing through adjacent drill holes unless otherwise directed.

5. **Production Blasting.** Drill the row of production blast holes adjacent to the pre-split blast line on a plane parallel to and no closer than 6 feet (1.8 m) to the pre-split blast lines. Do not drill the production hole bottoms lower than the pre-split hole bottoms and with a diameter not greater than 6-inches (155 mm).

Detonate production holes on a delay sequence toward a free face.

Stem production holes a minimum of 3 feet (915 mm) or 0.7 times the burden distance, whichever is greater, with sand or other dry, angular granular material passing a ⅜-inch (9.5 mm) sieve.

Perform production blasting to minimize blast damage to the backslope.

Production blasting is incidental to and included in the measurement and payment for unclassified excavation.

C. **Rock Excavated Below Grade.** Excavate all un-yielding materials that require blasting or the use of rippers to at least 6-inches (155 mm) below subgrade within the roadbed limits. Backfill the excavation with specified or approved material. Remove or drain surface rock pockets that trap or pond water.

Rock, removed to a maximum depth of 6-inches (155 mm) below subgrade is measured and paid for as unclassified excavation. Rock removed or backfilling due to over excavating in excess of the 6-inches (155 mm) with approved backfill material is at Contractor expense.

D. **Removing Excess Moisture.** Rework materials from excavation or borrow areas exceeding 2% of optimum moisture to the specified optimum moisture before use in embankments or as backfill. Costs to remove excess moisture from the material is incidental to the embankment.

Remove excess moisture in the finished roadbed soil, introduced or caused by construction operations, for re-use in the work at Contractor expense. Excessively wet material, caused by the construction operations that cannot be properly compacted must be removed and replaced with suitable material at Contractor expense.

E. **Borrow Material.** Excluding special borrow, borrow material may be used only after the roadway excavation has been placed in the embankment. If excess borrow is placed creating a waste of excavation, the waste quantity will be deducted from the measured volume in the borrow area.

Provide the Project Manager 5 calendar days notice before excavating material from the borrow area so that cross sections may be taken. Do not excavate beyond the dimensions and elevations established for the borrow areas. Finish and shape all borrow areas to permit accurate measurements. Reclaim borrow areas meeting Subsection 106.02.5 requirements

F. Step or Roughen Slopes. Step or roughen slopes as directed. Horizontally step cutslopes, excluding rock slopes that cannot be excavated by ripping, approximately 1 to 2 feet (305 by 610 mm) wide by 1 to 2 feet (305 to 610 mm) in height. Extend the steps the continuous length of the slope, even if the slope decreases to less than 2:1.

Start the steps immediately below the backslope rounding. Cut each step opposite in direction of the preceding cut.

Leave loose material deposited on the steps during construction. Stepped slopes are not topsoiled. Seed the completed sections of the stepped slope daily.

203.03.2 Embankment.

A. General. Do not place stumps, trees, logs, rubbish, vegetation, muck, frozen material, pockets of rock, or other deleterious materials in embankments.

Spread sod mixed with surface soil and soil containing excessive humus or other organic materials over the embankment slopes or incorporate it into the embankments outside of the shoulder lines.

Compact embankment, backfill and embankment foundation areas, under Subsection 203.03.3.

Leave the surface of completed embankments in a roughened condition.

B. Embankment at Structures. Do not place rocks, broken concrete, or other solid material in areas where piling is to be driven.

Do not place embankment against any backwall or abutment until the concrete has cured for 10 days or has reached 70% of the required strength. Furnish the Project Manager a certified laboratory test report showing the field cured cylinders meet the required strengths.

The Project Manager may approve early embankment work at backwalls or abutments with beams or girders in place, or that are cantilevered from a fixed footing or cap if the strength requirement is met.

Do not place embankment against un-supported backwalls or U-shaped abutments rigidly connected to the deck until the deck is placed and cured meeting the applicable requirements of Section 552.

The Contractor may submit to the Project Manager, a method of supporting the structure to permit early placement of embankment against the structure. If approved, all costs of the alternate method are at Contractor expense.

Place embankment in 8-inch (205 mm) maximum layers loose thickness and compact adjacent to structures, around columns and similar structural supports, and on both sides of concrete walls, box type structures, and similar structures. Extend embankment material placed above the excavation limits or ground line a minimum 10 feet (3 m) from the structure or structural support.

Restore, repair, or replace structures or structural members moved or distorted by placing and compacting embankment at Contractor expense.

Compact embankment inaccessible to rollers by mechanical tampers to the density specified in Subsection 203.03.3.

Before placing and compacting backfill, compact at least the top 8-inches (205 mm) of the existing ground under Subsection 203.03.3.

C. Preparation of Embankment Foundations. Bench all embankments placed and compacted on hillsides, against existing embankments; built one-half width at a time, or on slopes 6:1 or steeper when measured at right angles to the roadway centerline. Construct benches in minimum 4 foot (1.2 m) width. Maintain the horizontal inclination within 5 percent of horizontal. Backfill and compact each bench in maximum 8-inch (205 mm) layers.

Excavate each bench as close to each other as the slope will permit. Use approved material excavated from benches in the embankment.

In excavation to embankment transitions where the natural ground slope exceeds 6:1, construct the excavated benches so the natural ground surface is a minimum 12-inches (305 mm) from the top of the subgrade.

Remove frozen earth, snow and ice from the cut or embankment surface and place it outside the slope stakes at Contractor expense. Remove and dispose of this material at least 300 feet (91.5 m) ahead of the excavation and placing of the embankment.

Remove and waste frozen material, and provide the replacement borrow material at Contractor expense.

Clear the full width of the subgrade of sod and vegetative matter. Scarify the top 8-inches (205 mm) of the subgrade, water, and compact under Subsection 203.03.3 before constructing embankments 4 feet (1.2 m) high or less, or embankments placed on soils having less than 90 percent maximum density, determined by MT-210.

If lightly compacted soils are encountered that exceed 8-inches (205 mm) in depth, remove it to the depth directed. Compact the upper 8-inches (205 mm) of the ground under Subsection 203.03.3. Place the removed material in the embankment or use it for topsoil as directed. Material useable as topsoil may be placed alongside the roadway after compaction is completed.

Whenever a compacted road surface is within 3 feet (915 mm) of the subgrade, scarify the top 8-inches (205 mm) and re-compact under Subsection 203.03.3.

D. Earth Embankment. Place earth roadway embankment in uniform horizontal layers not exceeding 8-inches (205 mm) loose measurement and compact under Subsection 203.03.3. Continuously level, work, and maintain moisture to compact to the specified density. Uniformly work the entire surface of each layer.

Work each layer of earth embankment using a tandem type construction disk with a maximum disk spacing of 14-inches (355 mm) and a minimum worn disk diameter of 25-inches (635 mm). Larger disks may be used if the ratio of disk spacing to disk size is comparable to the above dimensions. Leave the embankment slopes in a roughened condition.

E. Rock Embankment. When the excavated material contains more than 25% rock by volume, 6-inch or larger (155 mm) in its greatest dimension, place the embankment in layers 2-inches (50 mm) thicker than the maximum size rock in the material not to exceed 24-inches (610 mm) loose thickness.

Individual rocks and boulders larger than 24-inches (610 mm) in diameter may be placed in the embankment if the rocks do not exceed 48-inches (1.2 m) vertical height after placement, are evenly distributed, and are spaced to allow placing and compacting of the soil in horizontal layers.

Place and compact the upper 2 feet (610 mm) of the embankment in maximum 8-inch (205 mm) layers loose thickness as specified in Subsection 203.03.2(D).

Dump and work rock from excavations to the stream face when the embankments are adjacent to streams or channels. Prevent the rock from entering the stream. This work is incidental to unclassified excavation.

F. Embankment Over Swampy Areas. On low, swampy ground incapable of supporting haul equipment, construct the lower part of the embankment by dumping successive loads of uniformly distributed material in layers thick enough to support the equipment. Place subsequent layers under Subsection 203.03.2 (D) or (E) as directed. Install erosion controls as specified.

G. Disposal of Unsuitable or Excess Material. Place excess or unsuitable excavated material, including rock and boulders, not useable in embankments in the side slopes of the nearest fill as directed. Dispose of excess or unsuitable material that cannot be incorporated into side slopes at Contractor expense. Slope and shape all disposal areas to blend into the surrounding terrain and meet the requirements of Subsections 106.02.5 and 107.11.

203.03.3 Moisture and Density Requirements. Compact each layer of material to the in-place density requirements of Table 203-1 for the method of moisture and density control used. The moisture and density control will be the Proctor method or the Zero Air Voids method, determined by the Project Manager.

For A-1 material in embankments, MT 218 and MT 230 tests will be used.

Compact safety slope embankments to a minimum 90% of maximum density with no optimum moisture requirement. The safety slope is the embankment placed from an existing shoulder to a catch point on the original ground not supporting any portion of the surfacing.

Compact rock embankments that cannot be tested by Montana Test Methods MT-212, MT-215, and MT-218 (Proctor Method) or MT-229 (Zero Air Voids Method) with compaction equipment and hauling and spreading equipment. Use grid rollers, pneumatic-tired rollers, vibrating rollers, vibrating compactors, or self-propelled tamping rollers. Do not use sheepsfoot rollers unless approved. Use water as required.

TABLE 203-1
COMPACTION REQUIREMENTS

COMPACTION CONTROL METHOD		
Material Compacted	**Proctor Method** Test Methods: MT-210 or AASHTO T99, MT-212, MT-215, MT-218	**Zero Air Voids Method** Test Method: MT-299
Earth Embankment Including all Backfills Top 8 Inches (205 mm) of Subgrade in Cut Sections Culvert Foundations	Minimum 95% of Maximum Density at Optimum Moisture ±2%	Less than 10% Air-filled Voids
Top 8 Inches (205 mm) of Embankment Foundations and Backfill Foundations	Minimum 90% of Maximum Density at Optimum Moisture ±2%	Less Than 16% Air-filled Voids

203.03.4 Sloping and Finishing.

A. Sloping. Finish and shape all cut slopes, ditches, embankments, and structure berms to a uniform, rough textured surface, except for stepped slopes. Scarify smooth slopes.

Where roadway slopes are not completed to the planned or directed lines and the material from the backslope erodes, sloughs, or slides due to incomplete erosion control measures or the Contractor's operations, the removal of the material and restoration of the slope is at Contractor expense.

Where roadway slopes are completed to the plan or directed lines, all required erosion control devices are in place as specified, and the material from the completed slopes erodes, sloughs, or slides onto the roadway prism before final acceptance of the work, through no fault of the Contractor, the removing of the slide material, potential slide material, and the drainage excavation is paid for at an agreed unit price or on a force account basis under Subsection 109.04.

When directed, widen cuts and flatten slopes to obtain additional excavation for embankments or to increase slope stability. The Project Manager may steepen stable rock slopes. This work is measured and paid for as unclassified excavation unless it requires non-contract construction methods increasing costs that are considered extra work under Subsection 104.03.

B. Finishing. Finish the entire roadbed to the final elevations specified. Do not place organic, or other deleterious material in the top 4-inches (105 mm) of the roadbed surface. Remove and dispose of partly buried oversize material not passing a 4-inch (105 mm) square-mesh screen from the roadbed surface. Finish the grade so it does not deviate more than 0.1 foot (30 mm) at any point from the staked elevation, and so the sum of the deviations from the true grade of any two points not more than 30 feet (9.2 m) apart do not exceed 0.1 foot (30 mm).

203.03.5 Maintenance of Constructed Roadway. Maintain the roadway during construction so it is continuously well drained.

Prevent erosion damage to embankments and stream siltation under Section 208. Keep all drainage ditches and structures open and free from debris until final acceptance.

If grading work is suspended, blade smooth and grade the entire roadway area to prevent water from collecting or ponding on the roadway. Maintain the roadway during suspension periods to the specified grade and cross section at Contractor expense.

Maintain erosion and siltation control devices meeting the Contract requirements at all times.

203.03.6 Topsoil-Salvaging and Placing. Remove topsoil from the excavation and embankment foundations to the specified depth without removing subsoil. Place topsoil on the completed graded roadway to the lines, grades, and elevations specified. Place topsoil on all slopes, excluding above the subgrade of the roadway inslopes and on slopes 2:1 or steeper. Place topsoil to an average 4-inch (105 mm) loose depth. Give preference to backslopes when placing topsoil.

Stockpile topsoil at acceptable selected locations within the right-of-way. When construction operations do not permit stockpiling within the right-of-way, make arrangements for stockpile sites outside the right-of-way at Contractor expense.

Construct stockpiles so drainage is maintained and topsoil is easily reclaimed. Provide erosion controls following best management practice.

203.04 METHOD OF MEASUREMENT.

203.04.1 Excavation. The quantities of unclassified excavation, unclassified borrow excavation, special borrow, unclassified channel excavation, street excavation, sub-excavation, and muck excavation for payment is the staked quantities calculated in cubic yards (cubic meters) under Subsection 109.01.

Remeasurements will be taken only: (1) in slide areas not the fault of the Contractor; (2) in excavated areas outside the staked lines and grades authorized by the Project Manager; (3) in un-staked areas such as borrow areas, muck excavations, sub-excavations, and un-staked excavations authorized by the Project Manager. These areas of excavation and borrow are measured in their original position by cross sectioning the areas excavated; and (4) if there is disagreement over the accuracy of quantities computed from the staked lines and grades. Either party to the Contract may request re-measurement of specific work areas.

Excavation requiring more than one handling before placement is measured and paid for at the contract unit price for unclassified excavation for each approved handling or may be paid for as another item of work for the second handling.

Authorized excavation of rock, shale, muck, or unsuitable material below grade necessary to provide the designed thickness of backfill is measured for payment. If the designated bottom plane of the excavation falls within a layer of rock, the below-grade excavation to the bottom of the layer, not exceeding 6-inches (155 mm) below grade, is considered authorized and is measured for payment. Rock excavation exceeding 6-inches (155 mm) below grade is not measured for payment. If the nature of the material, the thickness of the layers or strata, and method of

operations make it practical to excavate only to the plan depth, any material removed below plan depth is not measured.

Measurements are made for unusable materials excavated and removed.

Useable material temporarily removed and replaced for Contractor convenience is not measured.

The actual quantities of plan and approved sub-excavation are measured and added to the quantities of unclassified excavation for payment.

Material that can not be excavated by the methods used for the unclassified excavation is measured and paid for as muck excavation.

Muck excavation reworked under Subsection 203.03.1(D) is measured and paid for as unclassified excavation for the second handling.

Hauling muck excavation to the disposal areas is measured and paid for as haul under Section 206.

When the Contract does not contain a bid item for muck excavation and an area is determined unstable under Subsection 203.01.1 (E)(1 and 2), the muck excavation quantity is measured and paid for at an agreed price or force account basis under Subsection 109.04. Measurement and payment for muck excavation at the agreed price includes all excavating and hauling, disposing of all stumps, logs, and other debris encountered in the excavation, all pumping and de-watering required, and finishing of the planned disposal areas.

Material removed and replaced for Contractor convenience and removal and disposal of unusable materials from borrow areas is not measured for payment. Special borrow removed from areas before staking or cross sectioning is not measured for payment.

Unclassified excavation allowed for pre-split drill equipment clearance is calculated from the area bounded by the plan slope and lines parallel to plan slope, offset 2 feet (610 mm) for each 50-foot (15.2 m) increment in vertical cut height. The quantity for drill equipment clearance where the cut slope height is less than 50 feet (15.2 m) is not measured.

Excavation used as select or stockpiled select material is measured by the cubic yard (cubic meter) in its original position.

Removed and placed stockpile material is measured using the volume in its original excavated position.

Where it is impractical to measure material by the cross-section method, alternate methods involving three-dimensional measurements may be used.

Channel excavation is measured and paid for as unclassified excavation.

Street excavation is measured and paid for as unclassified excavation.

203.04.2 Drill Pre-splitting Holes. Drill pre-splitting holes are measured by the linear foot (meter). The measurement is made from the rock surface to the roadway grade or to a predetermined bench elevation. The quantity of drill pre-splitting holes shown in the Contract is not guaranteed, and the department reserves the right to increase or decrease this item with no adjustment in the contract unit price.

203.04.3 Embankment in Place. When the Contract contains a bid item for "Embankment in Place", all roadway excavation and construction of embankments is measured and paid for as embankment in place. The quantities measured in

cubic yards (cubic meters) for payment as embankment in place include the following:

1. The actual quantities of roadway embankment measured above the original ground line under Subsection 109.01, with no volume adjustments made for shrinkage, compaction, or subsidence;
2. The quantities of unsuitable or excess material used to flatten slopes, or otherwise disposed of, measured in its final position;
3. The topsoil replacement quantity measured in the topsoil stockpiles;
4. Minor excavation and sub-excavation directed by the Project Manager in its original position.

All other excavations are measured and paid for under other excavation bid items in the Contract or as extra work.

203.04.4 Compaction.

A. **Volume Measurement Method.** When roadbed compaction is specified in the Contract, the quantity measured for payment is the quantity of excavation incorporated in the roadway, measured under Subsection 203.04.1, excluding wasted material.

Road approaches, turnouts, wyes, and other similar facilities are included as part of the roadway. Measurement includes compaction of the natural ground cut sections under Subsection 203.03.3.

Water to reach the specified moisture content and compactive effort is not measured for payment and is incidental to roadbed compaction.

Compactive effort to obtain the specified densities includes scarifying, watering, aeration, and any other work to produce the finished roadbed and embankments.

B. **No Bid Item For Compaction.** When the Contract does not contain an item covering compaction, all work and materials to compact embankment material to the specified density is not measured for payment.

C. **Structure Backfill.** When there is no item for mechanical tamping, the compaction is not measured and paid for but is incidental to other items in this section. Compaction of structure backfill and at the ends of major structures is measured for payment if mechanical tamping is specified. Mechanical tamping is measured by the cubic yard (cubic meter) of backfill material and includes compaction of the ground below the backfill to a depth of 8-inches (205 mm).

203.04.5 Topsoil. Excavation of topsoil material from its original position, loading, hauling, stockpiling, and removal from the stockpile and spreading on the designated areas is measured for payment by the cubic yard (cubic meter) in the stockpile before final placement.

Before measurement, shape and smooth each stockpile into the smallest practical area. Haul is not measured.

Topsoil removed from cut areas is not deducted from the unclassified excavation, roadbed compaction, or haul quantities.

Measurement is made as if the topsoil had not been removed.

Topsoil removed from embankment before placing embankment and from borrow areas is measured as topsoil-salvaging and placing and is not measured for payment under any other pay items.

203.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities will be made under the following:

Pay Item	Pay Unit
Unclassified Excavation	Cubic Yard (cubic meter)
Unclassified Borrow Excavation	Cubic Yard (cubic meter)
Special Borrow	Cubic Yard (cubic meter)
Unclassified Channel Excavation	Cubic Yard (cubic meter)
Sub-excavation	Cubic Yard (cubic meter)
Muck Excavation	Cubic Yard (cubic meter)
Drill Pre-splitting Holes	Linear Foot (linear meter)
Embankment in Place	Cubic Yard (cubic Meter)
Roadbed Compaction	Cubic Yard (cubic meter)
Mechanical Backfill Compaction	Cubic Yard (cubic meter)
Topsoil	Cubic Yard (cubic meter)

Payment at the contract unit prices is full compensation for all resources necessary to complete these items of work under the Contract.

SECTION 204
EXISTING SURFACE PREPARATION

204.01 DESCRIPTION. Existing surface preparation is reshaping the typical section and truing the grade line of a previously completed earth subgrade or gravel or bituminous-surfaced roadbed for new surfacing construction.

204.02 RESERVED.

204.03 CONSTRUCTION REQUIREMENTS.

204.03.1 Subgrade. Excavate and remove all areas in the roadway subgrade not meeting moisture and density requirements. Backfill the excavations with approved material.

Grade the entire subgrade surface to the specified lines and grades and compact under Subsection 203.03.3.

Grade the roadway ditches to drain. True shoulder lines and shape and slope roadway inslopes uniformly.

Maintain the subgrade surface until the surfacing is placed.

204.03.2 Aggregate surfaces. Excavate, backfill, and re-compact all existing aggregate surfaces not meeting moisture and density requirements to the typical cross section and profile grade.

Complete compaction and surface smoothness using equipment meeting Section 210 requirements and meeting compaction and smoothness requirements in Subsection 301.03.5(D) & (G).

204.03.3 Bituminous Surfaces. Dispose of existing bituminous surface designated to be removed under Subsection 202.03.3.

Re-work all existing bituminous surfaces designated to remain in place as specified.

Before placing the leveling course, clean the existing surface of dirt and loose, extraneous material. Apply a prime or tack coat of bituminous material to the cleaned surface as specified.

Correct dips, depressions, sags, excessive or nonexistent crown, and other surface irregularities using a premixed bituminous mixture. Spread the mixture in 2-inch (50 mm) compacted layers.

Correct surface irregularities exceeding 6-inches (155 mm) deep using untreated aggregate material before leveling with a bituminous mixture.

204.04 METHOD OF MEASUREMENT. Existing surface preparation is measured under the respective contract items used in the work.

The materials and equipment required for existing surface preparation include, but are not limited to, aggregates for the subgrade and aggregate surfacing courses, bituminous material for prime and tack coats, bituminous-mixed surfacing for the leveling material, and watering and rolling.

Materials and equipment used to complete existing surface preparation, not incidental to, or included with other bid items in the Contract, are measured and paid for on a force account basis under Subsection 109.04.

204.05 BASIS OF PAYMENT.

Existing surface preparation is paid for at the contract unit prices for the material and equipment required to complete the work and on a force account basis for those items required but not having bid items.

The contract unit price paid for plant mix bituminous material spread for leveling includes the spreading, leveling, and compaction of the material.

SECTION 206
HAUL

206.01 DESCRIPTION. Haul is transporting excavation or aggregate surfacing material from its original location to its final location in the work.

206.02 RESERVED.

206.03 RESERVED.

206.04 METHOD OF MEASUREMENT.

206.04.1 Excavation Haul. The haul distance for excavation material moved from:

A. Outside the roadway is measured along the shortest route determined by the Project Manager.

B. Within the roadway and placed inside the roadway is measured along the centerline of the roadway.

Haul is computed by multiplying the number of cubic yards (cubic meters) of excavation removed from its original position by the mean distance it is hauled. The distance between the center of volume of the excavation and the center of volume of the embankment is the haul distance.

Excavation and embankment volumes for ramps, frontage roads, road approaches, driveways, and connections on either side of the roadway is considered concentrated at the centerline or at a line parallel with the main roadway under construction for computing haul quantities for payment.

The number of cubic yards (cubic meters) hauled is determined by measuring the materials in their original position with no allowances for swell occurring when the materials are excavated and loaded into the haul units.

206.04.2 Aggregate Haul. Aggregate haul is measured by the ton-mile (metric ton-kilometer) or mile-cubic yard (kilometer-cubic meter) for haul of aggregate over an approved route. The number of ton-miles (metric ton-kilometer) or mile-cubic yards (kilometer-cubic meter) is the product of miles (kilometer) times tons (metric ton) or cubic yards (cubic meters) of material hauled. The haul distance is measured to the nearest 0.1 mile (10 m) along the shortest practical route from the loading point to the point where placed.

206.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Excavation Haul	mile-cubic yard (kilometer-cubic meter
Aggregate Haul	ton-mile (metric ton-kilometer) or mile-cubic yard (kilometer-cubic meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

When not specified as Contract pay item, haul is not measured or paid for but is incidental to and included in payment for other items of the Contract.

SECTION 207
CULVERT EXCAVATION AND TRENCH EXCAVATION

207.01 DESCRIPTION. This work is the excavation for placing or removing drainage and other appurtenant structures. It includes foundation preparation, backfilling, disposal of excavation material, bailing, drainage, sheeting, shoring and cribbing. Excavation classes are described below:

207.01.1. Culvert Excavation. Culvert excavation is all work under Subsection 207.01, where vertical walls are not required and the excavation width is not specified.

207.01.2. Trench Excavation. Trench excavation is the excavation for placing or removing storm drains, sanitary sewers, water lines, and other installations in the Contract. Vertical trench walls, when required, must be shored or supported to meet the U.S. Department of Labor, Occupational Safety and Health Administration, Safety and Health Regulations for Construction (O.S.H.A.). Trench widths are specified in Subsection 207.03.3

207.02 RESERVED.

207.03 CONSTRUCTION REQUIREMENTS.

207.03.1 General. Excavate to permit removal, jointing and backfilling of pipe.

Construct and maintain the excavations to prevent personal injuries, damage to foundations, structures, pole lines, or other facilities.

Pile and maintain all excavated material to meet O.S.H.A. requirements and with a minimum of inconvenience to the public. Do not obstruct fire hydrants, water valves, meters, and the free flow of storm water in gutters, other conduits, and natural water courses.

Do not excavate below the specified depth, except as permitted in Subsection 207.03.6.

Remove all obstructions in the excavation at Contractor expense.

Backfill excavated areas to meet Subsection 603.03.4. Do not place backfill against newly constructed masonry or concrete structures for at least 14 days. Remove all sheeting and bracing before backfilling.

207.03.2 Culvert Excavation. When special foundation stabilization is specified, excavate the bedding trench walls vertically and the trench width to provide room for the bedding material.

207.03.3 Trench Excavation. Keep trench lengths to a minimum in paved roadways, sidewalks, or other improved areas, in advance of the pipe laying and not to exceed 200 feet (61 m). Keep trench backfilling and compaction to within 300 feet (91.5 m) of the installed pipe.

Cut the pavement full depth vertically along regular neat lines in paved roadways that require patching. Excavate the minimum trench width possible.

When vertical trench walls are specified, the maximum trench width is the external width of the pipe barrel plus 3 feet (915 mm). When a special foundation is specified, excavate the bedding trench walls vertically and the trench width as specified.

Do not exceed the specified trench width without the Project Manager's approval when vertical trench walls are specified.

Furnish any additional select backfill material and additional surface and subsurface improvements if the maximum trench width is exceeded at Contractor expense.

207.03.4 Excavation for Appurtenant Structures. Excavate for riprap, rubble masonry, retaining walls, cutoff walls, headwalls, manholes, drop inlets, catch basins, headgates, division boxes, and other structures appurtenant to culverts, sewers, drains, pipes, or tubing to meet the applicable requirements of Subsection 207.03.1.

207.03.5 Shoring. Provide and remove shoring or supports for the excavation walls, that protect the work, existing property, utilities, pavement, and other existing facilities. Provide safe working conditions meeting O.S.H.A., local and state safety codes.

Repair damage caused from excavation support failure or from failure to provide support at Contractor expense.

207.03.6 Foundation Preparation. Compact foundations for culverts, sewers, drains, pipes, tubing, and appurtenant structures to the moisture and density requirements of Subsection 203.03.3.

Remove unstable or unsuitable material encountered below the excavation floor elevation and replace with material meeting Subsection 701.04.2. Cover with bedding material meeting Subsection 701.04.1 as directed. The Project Manager will investigate unstable pipe installations requiring 4 feet (1.2 m) or more of foundation material.

Remove unyielding material below the staked elevation to at least 12-inches (305 mm) and replace with bedding material meeting Subsection 701.04.

Bed culverts larger than 12-inches (305 mm) as shown in the Detailed Drawings. Place bedding for 12-inch (305 mm) diameter and smaller culverts to uniformly support the culvert throughout its length. The bedding does not need to conform to the outside of the culvert.

Do not lay pipe until the foundations are approved by the Project Manager. Remove and relay pipe laid on unapproved foundations at Contractor expense.

Use Class C foundation for reinforced concrete pipe.

207.04 METHOD OF MEASUREMENT. Culvert and trench excavation is measured in its original position by the cubic yard (cubic meter) as follows:

Culvert excavation measurement is the volume bounded on the bottom by the established elevations for the excavation floor; on the sides by vertical planes 12-inches (305 mm) outside of the inside walls of the pipe or culvert,

and on the ends by vertical planes 12-inches (305 mm) outside the neat lines of the pipe or culvert.

Trench excavation measurement is the volume bounded on the bottom by the elevations established for the excavation floor, on the sides by vertical planes 18-inches (460 mm) outside of the inside walls of the pipe or culvert, and on the ends by vertical planes 12-inches (305 mm) outside the neat lines of the pipe or culvert.

Culvert or trench excavation within the structure neatlines for culverts, sewers, drains, pipes, tubing, or other installations entering structures is not measured for payment.

When a special foundation is required, measurement is the distance between the vertical planes bounding the sides of the special foundation of the bedding trench.

In cut sections, culvert excavation and trench excavation are not measured for payment above the staked template section. When the Project Manager requires culvert excavation or trench excavation before excavation for the template section, the culvert excavation or trench excavation is measured to the existing ground surface.

In fill sections, culvert excavation and trench excavation is not measured for payment above the natural ground line as cross sectioned.

Shoring for culvert excavation and trench excavation is not measured for payment. Sheeting materials directed to be left in place are paid for under Subsection 207.05.

Measurement of excavation for flared end terminal sections or special end sections is based on regular barrel dimensions extended through these sections.

Excavation and foundation preparation for appurtenant structures is not measured for payment.

Bedding material and foundation material is measured under Subsection 603.04.3.

207.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Culvert Excavation	Cubic Yard (cubic meter)
Trench Excavation	Cubic Yard (cubic meter)
Bedding and Foundation Material	Cubic Yard (cubic meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

Sheeting materials directed to be left in place are paid for at invoice cost supported by material and freight bills. No additional allowance is made for installation, handling, overhead, insurance, profit, or any other costs.

Payment for excavation and foundation preparation for appurtenant structures is included in payment for the respective structural items.

SECTION 208
WATER POLLUTION CONTROL AND STREAM PRESERVATION

208.01 DESCRIPTION. Water pollution control is the planning, scheduling, constructing and maintaining of Contract pollution and erosion control devices, devices proposed by the Contractor, or ordered by the Project Manager during the work to prevent and control the siltation of lakes, streams, rivers, ponds, and other wetlands.

Leave permanent pollution controls in place after the work is complete. Temporary pollution controls are to prevent polluting state waters during the work.

The Department's "Standard Erosion Control Work Plan Manual" is a guide to devices and measures to prevent pollution and erosion. The work includes preventing ground water pollution.

Use temporary and permanent water pollution controls to provide economical, effective, continuous erosion and pollution control during and after the work.

Plan and install temporary pollution control devices to preserve existing streambeds and streambanks.

208.02 MATERIALS. Use materials meeting commercial grade standards approved by the Project Manager if permanent and temporary materials are not specified.

208.03 CONSTRUCTION REQUIREMENTS.

208.03.1 General. Comply with the Department of Fish, Wildlife and Parks, Department of Health and Environmental Sciences, and all other state or federal laws or regulations for preventing or abatement of erosion, water pollution, and siltation.

208.03.2 Water Pollution Control. Submit to the Department of Health and Environmental Sciences an Erosion Control Plan covering all construction areas to be disturbed outside the highway right of way 30 working days before starting work. During construction, follow the plan to prevent polluting and silting of state waters. Prevent chemicals, fuels, lubricants, bitumens, raw sewage, and other wastes from entering state waters. Dispose of all wastes, refuse, and discarded materials meeting Subsection 107.11.

Control erosion, siltation, and water pollution during all work suspensions.

Contractor failure to provide erosion and water pollution controls is cause for the Project Manager to provide the work and deduct those costs from monies due or that may become due the Contractor.

A. **Water Pollution Control Plan.** Submit a water pollution control plan to the Project Manager at the pre-construction conference or 30 working days before work starts. The Department has 30 days to review the plan. Incomplete or illegible plans will be returned for correction and the 30 day review time begins upon receipt of the corrected plan.

   Include in the plan the schedule for incorporating the permanent erosion control work and all temporary controls proposed for use during the

work. Do not begin work that disturbs the natural ground until the plan is approved. Revise and update the water pollution control plan whenever the required controls differ from the approved plan. Submit all changes for review and approval. Meet the Contract requirements and follow the approved pollution control plan.

B. **Temporary Pollution Control Measures.** Install temporary erosion control before each construction stage.

Maintain all temporary erosion control until it is no longer needed or conflicts with the work. If devices that conflict with the work are removed, replace these devices at the end of each shift. Re-grade temporary sites to match the surrounding terrain after the devices are removed. Repair or replace damaged, inadequate, or non-functioning devices.

Temporary pollution control measures required due to the Contractor's negligence, carelessness, or failure to install permanent controls are at Contractor expense.

C. **Permanent Pollution Control Measures.** Install permanent pollution controls concurrently or immediately following work that disturbs natural ground.

208.03.3 Limitations on Grading Operations. The maximum area allowed to be disturbed at one time within the highway right-of-way is 750,000 square feet (69,750 m^2) of clearing and grubbing and 750,000 square feet (69,750 m^2) of borrow, excavation and embankment.

The Engineer may modify the 750,000 square feet (69,750 m^2) restriction when soil characteristics, contractor operations or both, indicate that a smaller or larger area is acceptable. For long or complex projects, the Contractor may have several separate grading operations working, where the Engineer may apply the limit to each individual operation, provided finishing, mulching, and seeding closely follow the rough grading operations at each location. Use the specified pollution controls at each individual location.

208.03.4 Stream Preservation.

A. **General**. Meet the following general provisions unless the plan approved by the Department of Fish, Wildlife, and Parks under Subsection 208.03.4(B) is more restrictive:

1. Clear and grub adjacent to streams or associated wetlands meeting Subsections 201.03.2 and .3.
2. Do not operate mechanized equipment in any stream.
3. Do not spill or dump material from equipment into streams or associated wetlands.
4. Do not permit wash water from cleaning concrete related equipment or wet concrete to enter streams, riparian areas, or wetlands.
5. Do not place fill or embankment material in streams, streambeds, wetlands, or riparian areas.
6. Locate staging or storage areas at least 50 feet (15.2 m) horizontally from the highest anticipated water level during the construction period.
7. Store and handle petroleum products, chemicals, cement and other deleterious materials to prevent their entering streams and associated wetlands.

8. Provide sediment controls for drainage from topsoil stockpiles, staging areas, access roads, channels changes, and instream excavations.
9. Reclaim streambeds and streambanks as close as possible to their pre-disturbed condition.

B. Temporary Construction Facilities. Plan temporary construction facilities to:

1. Minimize disturbance to streambank, streambank vegetation, streambed, and state waters;
2. Not restrict or impede fish passage in streams;
3. Not restrict any water flow anticipated during use.

Install, maintain, operate, and remove temporary construction facilities meeting the approved work plans within or adjacent to streambeds and for crossing streams, streambeds or state waters.

Maintain constant progress once installation or removal work begins. Shape and contour areas disturbed by installation and removal to match adjacent undisturbed ground.

Furnish plans meeting the Department of Fish, Wildlife, and Parks requirements for approval for work bridges, haul bridges, bridge removal, detours, and other temporary construction facilities. Include the following in the plans:

a. Details of stream and streambank features before installing temporary construction features and after they are removed;
b. Location of facilities relative to permanent work and streambanks;
c. Plan and elevation views of facilities showing stream section;
d. Anticipated high water elevation during use of the facilities;
e. Waterway openings and clearances;
f. Type of bridge bent, pier, and superstructure construction (wood, steel, concrete, etc.);
g. Written description for installing, operating, and removing facilities;
h. Estimated time facilities will be in place.

Submit 5 copies of the plan to the Project Manager, who will forward 2 copies to the Department of Fish, Wildlife, and Parks for approval. Submit to the Project Manager revised plans or modifications to approved plans. The Departments have 30 working days to review both the original and all plan modifications. Do not begin work on temporary construction facilities or modifications to approved plans until receiving written approval from the Department of Fish, Wildlife, and Parks.

Defend, indemnify, and save harmless the Department from legal actions or fines resulting from violations of the Stream Protection Act, Section 87-5-501 to Section 87-5-509, MCA, because of any act, omission, neglect, or Contractor misconduct.

208.03.5 Seeding.

A. Permanent Seeding. Seed all finished areas designated for permanent seeding under Subsection 610.03.2.

Finished slopes permanently seeded during the seeding season may require frequent seeding to establish an acceptable stand.

Finish, topsoil, fertilize, mulch, seed, and place permanent erosion control as slopes are finished and not at the Contractor's convenience.

Recondition, re-mulch, re-fertilize, and re-seed areas that fail to establish an acceptable stand during the specified seeding periods.

B. Temporary Seeding. Temporarily seed all disturbed soil areas that will not be re-disturbed for 21 days or more by the 14th day after the last disturbance. Areas not requiring further disturbance may be permanently seeded. Re-seed permanently seeded areas that fail to establish a sustainable growth at Contractor expense.

208.04 METHOD OF MEASUREMENT.

208.04.1 Temporary Water Pollution Controls. Temporary water pollution controls are measured by the unit.

Stream preservation is included in Temporary Water Pollution Control and is not measured for payment.

208.04.2 Seeding. Seeding is measured by the acre (hectare) and includes finishing, topsoiling, fertilizing, mulching and seeding.

208.04.3 Permanent Water Pollution Control. Permanent water pollution control items are measured by the unit under the respective bid item.

208.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Temporary Pollution Control	Force account, agreed price or Unit
Seeding	Acre (hectare)
Permanent Pollution Control	Unit

Additional compensation is not considered or allowed the Contractor for delays in securing approvals for temporary construction facilities or authorization to discharge under the Montana Pollutant Discharge System.

An estimated quantity of units for temporary pollution control is shown in the Contract based on one dollar per unit. For example, an estimated quantity of 20,000 units is equivalent to $20,000 of temporary water pollution control work. The total number of units in dollars of temporary water pollution control work estimated in the Contract may be increased or decreased by the Project Manager as required.

Temporary water pollution control maintenance and removal is paid for on a force account basis.

Payment for the completed and accepted quantities is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 209
STRUCTURE EXCAVATION

209.01 DESCRIPTION. Structure excavation is excavating bridge foundations and all other structure foundations. The item includes disposing of excess or unsuitable material from the excavations, backfilling to the original ground level, bailing, pumping, draining, sheeting, shoring and cribs.

209.01.1. Structure Excavation Type I. Structure Excavation Type I is excavating, de-watering, shoring and cribbing, and backfill and compaction for the excavation.

209.01.2. Structure Excavation Type II. Structure Excavation Type II is excavating, de-watering, backfill and compaction for the excavation excluding shoring and cribbing.

209.01.3 Shoring and Cribs. This is constructing and removing all shoring and cribs, cofferdams or caissons, and for all material, labor, equipment, tools, and incidentals to complete the work.

209.02 RESERVED.

209.03 CONSTRUCTION REQUIREMENTS.

209.03.1 General. The plan excavation lines in the Contract are estimated. Excavate all foundations to the plan elevations and dimensions.

Removing boulders, logs, and other obstructions found in the excavation is incidental to this work.

Remove timber, sheeting, and other material used in the excavation before backfilling.

Remove and stockpile all excavated material that is suitable for backfill.

209.03.2 Treatment of Foundation Materials. When the excavation reaches the designated depth, de-water, clean, and maintain the excavation until the foundation bed is inspected.

Clean and fill rock seams and crevices with concrete mortar.

Obtain the Project Manager's approval of the foundation before placing concrete on the foundation.

Place concrete without disturbing the bottom of the excavation.

Minimize disturbance of the natural ground outside the excavation pay limits except as required for constructing cofferdams.

209.03.3 Cofferdams. Submit drawings and calculations prepared by a registered engineer showing the proposed method of cofferdam construction and de-watering procedures before starting the work. The cofferdam must meet O.S.H.A. requirements.

Assure cofferdams or cribs for foundation construction are watertight to permit de-watering.

Provide clearance within the cofferdam for constructing forms, inspection of the form exteriors, and for pumping.

Re-align or enlarge the cofferdams or cribs that are tilted or moved laterally during the work to provide work clearance at Contractor expense.

Timber bracing may be left in cofferdams or cribs extending into the substructure masonry with the Engineer's written approval.

When weighted cribs are used to resist the hydrostatic pressure acting against the bottom of the foundation seal, use an anchorage to transfer the entire weight of the crib to the foundation seal. When the foundation seal is placed, vent or port the cofferdam at the cofferdam design low-water level.

The foundation seal depths in the Contract are based on the estimated, normal water-surface elevations or are consistent with those satisfactorily used on past projects.

The specified seal thickness is a minimum. The Contractor may request an increased seal depth. Submit the request in writing to the Engineer for approval. Any approved increase in seal depth and associated costs are at Contractor expense.

Repair or replace failed cofferdams, foundation seals or both at Contractor expense.

Pump out the cofferdam and place the remaining masonry or concrete in the dry after meeting the time limit in Subsection 209.03.4.

Remove all cofferdam or crib material after the substructure is complete without disturbing or marring the finished work.

209.03.4 Pumping Water from Cofferdams. Pump interior foundation enclosures without disturbing the in-place concrete. Do not pump for at least 24 hours after placing concrete unless pumping from a sump separated from the concrete work by a watertight wall.

209.03.5 Inspection. Place the footings as soon as practical after the excavation depth and the foundation material are approved.

Drill holes or drive rods in the excavation bottom to determine the materials quality when requested by the Project Manager.

Excavate the spread footings and take rod soundings at each individual substructure unit and submit rod soundings simultaneously for the footing elevation approval.

209.03.6 Backfilling. Once approved, backfill and compact all excavated areas without damaging adjacent structures, to match the existing ground line.

Place backfill to be covered by roadway embankment in maximum 8-inch (205 mm) loose thickness, continuous horizontal layers.

Compact each layer meeting Subsection 203.03.3.

Remove and dispose of backfill containing large or frozen lumps, wood, or other deleterious materials. Do not jet or pond the backfill.

Serrate or step the slope bounding the excavation for abutments and wingwalls.

Place coarse gravel or broken stone around drain holes in wingwalls or abutments as shown on the plans.

Backfill around piers and in front of abutments and wingwalls with material large enough to resist erosion. If acceptable material is not available, the Project Manager may order stone or lean concrete backfill, paid for as extra work.

Place backfill against masonry abutments, and wingwalls meeting Subsection 203.03.2(B). Allow culvert related concrete work to cure 14 days before backfilling.

Dispose of excess material.

209.04 METHOD OF MEASUREMENT.

209.04.1 Structure Excavation Type I and Type II. Measurement in cubic yards (cubic meters) is based on the volume bounded on the sides by vertical planes 18-inches (460 mm) outside of the footing neat lines; on the top by the original undisturbed ground surface at the time excavation begins or by the lines in the Contract; and on the bottom to the specified footing elevation or the elevation directed by the Engineer.

Calculations for tie beams, overhangs, or similar volumes extending beyond the footing lines are computed from lines 18-inches (460 mm) outside of and below neat lines. The computed structure excavation includes only those portions not contained in the volume of footing excavation.

209.04.2 Shoring and Cribs. Shoring and cribs are not measured for payment.

209.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Structure Excavation Type I	Cubic Yard (cubic meter)
Structure Excavation Type II	Cubic Yard (cubic meter)
Shoring and Cribs	Lump Sum

Additional approved material for backfill provided from other sources is paid for as extra work. Payment includes the costs of obtaining the material, processing, handling, and transporting to the project. The cost of placing and compacting the additional material and disposing of unsuitable material is included in the contact unit price for structure excavation.

No payment is made for additional material placed outside structure excavation pay limits and slope lines to comply with safety regulations.

No payment is made for additional material to replace material removed from the excavation, rendered unsuitable by improper excavation, handling, or stockpiling methods.

The following percentages of the total quantity of Structure Excavation Type I or II, when removed, are allowed for payment on progress estimates:

1. 85 percent when removed to plan elevation;
2. 95 percent when backfilled and compacted;
3. 100 percent when the area is cleaned up to the Engineer's satisfaction.

Payment for shoring and cribs is made at the contract lump sum price.

The following percentages of the contract lump sum price for shoring and cribs is allowed for payment on progress estimates:

1. 65 percent when shoring and crib is in position;
2. 90 percent when driven to final elevation;
3. 100 percent when shoring and crib is removed and the area is cleaned up to Engineer's satisfaction.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 210
EQUIPMENT USE

210.01 DESCRIPTION. This describes the equipment to be used for the Contract work.

210.02 RESERVED.

210.03 CONSTRUCTION REQUIREMENTS.

210.03.1 General Requirements. Provide equipment in good mechanical condition having sufficient power to perform the work. Repair or replace equipment not meeting these requirements.

210.03.2 Motor Graders. Use self propelled motor graders either tandem or all-wheel drive equipped with pneumatic tires. Equip the graders with a moldboard at least 12 feet (3.7 m) long with a cutting edge, a scarifier with nine or more teeth having minimum dimensions of 3 x 1 x 16 in.(75 mm X 25 mm X 405 mm), and power-operated controls.

The motor grader manufacturer's power rating must be at least 100 horsepower (75 kW).

210.03.3 Dozers. Use dozers of any standard type attached to a crawler tractor of at least 75 horsepower (56 kW) having power-operated controls.

Furnish dozers a minimum 90-inches wide (2.3 m). The dozer and tractor is considered a single unit.

210.03.4 Rollers.

A. General. Provide rollers and compaction equipment of standard manufacture bearing the manufacturers identification label. Roller weight is the manufacturer's rating.

Use self-propelled rollers capable of reversing direction without backlash.

Keep rollers in good mechanical condition with positive, accurate steering control.

Use adequately powered trucks or tractors for pull-type rollers.

Other than traction units, operate rollers separate and distinct from other equipment.

Equip all rollers with self-cleaning devices that prevent material from adhering to the wheels or tamping surfaces.

B. Smooth-Wheeled Rollers. Use smooth-wheeled, self propelled rollers as follows:

1. Tandem-type weighing up to 10 tons (9 mt).
2. Three-wheeled type weighing a minimum 10 tons (9 mt).
3. Towed steel-drum rollers weighing a minimum 4 tons (3.6 mt).

C. Tamping Rollers. Use tamping rollers with grids, drums, or shells surrounded by metal studs, pads, or similar elements that compress small areas of material.

D. **Pneumatic-Tired Rollers.** Use Pneumatic-tired rollers meeting the following:
   1. Two-axle type, straight or oscillating;
   2. Rigid framed providing a platform or body for ballast loading;
   3. Having a effective rolling width of at least 4 feet (1.2 m);
   4. Having a minimum working weight capacity of 250 pounds (113.5 kg) per inch width of tire tread;
   5. Smooth tires (no tread) equal in size and diameter;
   6. Rear axle tires spaced to overlap the tread gap of the preceding two tires;
   7. Uniform tire pressure not varying from each other by more than 5 pounds per square inch (34.5 kPa);
   8. Self-propelled or tractor or truck drawn (tractive power).

   Operate the rollers, while turning, to prevent tearing or loosening of the material being rolled or the adjacent material.

   Do not use wobble-wheeled pneumatic-tired rollers for bituminous surfacing work.

E. **Vibratory Rollers.** Use vibratory rollers capable of obtaining the required compaction.

210.03.5 Watering Equipment. Furnish and operate pneumatic-tired water equipment having spray bars capable of uniformly distributing water over the surface area. The control valves must be positive closing to prevent leakage.

210.03.6 Test Trailers Transport and Setup. Transport to the project site or provide electrical power service or both for State-owned test trailers. Supply electrical power 24 hours a day, 7 days a week. Transport, set up, and make the trailer operational before starting plant mix paving.

Paving operations will be suspended if power level requirements are not maintained.

Obtain a M.R.C. licensed carrier to transport the 12 foot (3.6 m) by 32 foot (9.8 m) test trailer from a designated location to the project site and return it to a designated location as directed. Transporting includes blocking, leveling, re-blocking, re-leveling and unblocking the trailer. Contact the Engineer for details concerning the transport of the trailer at least 30 days before plant mix operations.

Purchase a minimum $60,000.00 insurance for the trailer and its contents. Provide written proof of insurance to the Engineer before the trailer is moved. Verify that the Department has prepared the trailer and contents for transport.

Repair or replace all contents and trailer damage occurring in transport at Contractor expense. Do not move the trailer without the Engineer's permission.

Furnish and install a continuous 200 ampere, 220 to 230 volt, single phase, 60 hertz power supply to the trailer. Have the source connected by a Montana licensed electrician using a 4 wire conductor.

210.03.7 Test Trailer Power and Blocking. Provide a level parking area, the required blocking, and electrical power service for the test trailer. Locate and construct the parking area a minimum 200 feet (61 m) from the plant mix dryer

drum, mixing plant, and storage silo unless otherwise directed, to accommodate the 12 foot X 32 foot (3.6 m X 9.8 m) trailer. Park, block, and level the trailer as directed.

Do not begin plant mix paving operations until the trailer is operational. Suspend paving work during power interruptions or periods of insufficient power to the trailer.

Furnish, install, and connect a commercial or generated power meeting Subsection 210.03.06 requirements.

Unblock the trailer and disconnect the power as directed. The Department will prepare the trailer for transport.

210.04 METHOD OF MEASUREMENT.

210.04.1 Equipment Use. Equipment use, when specified as a bid item, is measured by the hour for the hours performing the work and includes furnishing the equipment, including operator, servicing, repairs. Time in moving equipment from point to point on the project and for repair and servicing is not measured.

Equipment used in the work but not specified as a bid item is incidental to the work.

210.04.2 Test Trailer, Transport, and Setup. Test trailer, transport and setup is measured by the mile (kilometer) for the actual miles (kilometers) moved. It includes insurance, transporting, blocking, unblocking, leveling, furnishing and installing electrical power and associated wiring, and all other necessary resources to complete the item of work. The mileage shown in the contract is an estimate only and may be adjusted by the Engineer.

210.04.3 Test Trailer, Power, and Blocking. Test trailer, power and blocking includes constructing a level parking area, blocking, leveling trailer, furnish power and wiring, unblocking, and removing power and wiring. This is a lump sum item.

Maintenance re-blocking and re-leveling is incidental to the work and not measured or paid for separately.

Additional blocking and leveling of the trailer for trailer moves directed by the Engineer are measured and paid for.

210.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Motor Grader	Hour
Dozer	Hour
Test Trailer Transport/Setup	Mile (Kilometer)
Test Trailer Power/Blocking	Lump Sum

Fifty percent of the lump sum price is paid when the trailer is blocked, leveled, and power is supplied.

Fifty percent of the lump sum price is paid when the trailer is unblocked and the power is disconnected.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 211
ROAD LEVELER OPERATIONS

211.01 DESCRIPTION. Road leveling is using a road leveler to final shape the top surfacing course.

211.02 RESERVED.

211.03 CONSTRUCTION REQUIREMENTS.

211.03.1 Equipment. Use either a self-propelled or tractor-powered unit designed for road leveling work.

A. Leveler Unit. Furnish a leveler unit:

1. Approximately 40 feet long (12.2 m);
2. With a minimum cutting blade width of 10 feet (3.0 m);
3. With pivot points, both in front and behind the center point of the machine;
4. Mounted on pneumatic tires or crawler-type treads;
5. With hydraulic power fittings to control the cutting blade from the power traction unit.

Machines less than 40 feet (12.2 m) in length may be used if operated off an approved string line using electronic controls.

B. Tractor Power Unit. Use tractor-power units capable of operating the leveler up to 4 miles per hour (6.4 km/hr).

Equip the unit with a two-way hydraulic system having controls for operating the leveler cutting blade.

211.03.2 Operation. Once the final surface course material is finished, bring the surface to the specified tolerance.

Apply water to the surface as required for leveling.

Operate the leveler longitudinally, starting from the crown of the roadway working toward the shoulder on successive passes with each pass overlapping.

Do not straddle the roadway crown with the leveler.

211.04 METHOD OF MEASUREMENT. Road leveler operation is measured by the hour for the actual hours used in the work.

211.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Road Leveler	Hour

Price and payment is full compensation for furnishing all resources necessary to complete the item of work under the Contract.

SECTION 212
OBLITERATE ROADWAY

212.01 DESCRIPTION. Obliterate roadway is the blading, scarifying, dozing, shaping, seeding, and disposing of structures and guardrail not included for removal under other items of the Contract on existing portions of abandoned roadways designated for obliteration.

212.02 RESERVED.

212.03 CONSTRUCTION REQUIREMENTS. Grade and contour abandoned roadways to blend with the new roadway and existing terrain.

After the old roadway surfacing is removed and rough grading is completed, scarify or plow the area to work the remaining surfacing material in with the ground. Harrow, smooth, and seed the entire area of the obliterated roadway to blend into the adjacent terrain.

Work construction scars, sharp breaks, and steep slopes or cuts to blend with the terrain. Existing surface material may be used in the new work or to construct fills over old roadways when covered with 12-inches (305 mm) soil capable of supporting plant growth.

Remove and dispose of old structures, guardrail, and other non-salvageable items not included in other contract items for removal at Contractor expense. Remove and neatly store all material designated as salvageable to prevent damage.

The species of seed, seed bed preparation, fertilizing, mulching, and application rate is specified in the Contract or will be determined by the Department Agronomist.

212.04 METHOD OF MEASUREMENT. Roadway obliteration is measured in stations to the nearest whole station along the centerline of the roadway obliterated or by the cubic yard (cubic meter), as specified.

When not included in the Contract as a pay item, roadway obliteration is measured by the cubic yard (cubic meter) under Subsection 203.04.

212.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Roadway obliteration	Station or Cubic yard (cubic meter)

Material obtained from the obliterated roadway and used in the construction of the new roadway is measured and paid for as unclassified excavation and haul under Sections 203 and 206 respectively.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 301
AGGREGATE SURFACING

301.01 DESCRIPTION. This work is producing and placing one or more courses of aggregate surfacing on a prepared surface or producing and stockpiling aggregate surfacing.

301.02 MATERIALS.

301.02.1 Aggregates. Obtain aggregates from sources meeting Section 106 requirements to produce material meeting the following:

Selected Surfacing	Subsection 701.02.2
Sand Surfacing	Subsection 701.02.3
Crushed Base Course	Subsections 701.02.4 and .5
Crushed Top Surfacing	Subsections 701.02.6 and .7
Crushed Cover Aggregate	Subsection 701.02.8

301.02.2 Binder. Binder material, for binding and gradation requirements, is fine, natural soil particles or crusher dust, free from grass, roots, weeds, humus, or other deleterious matter.

Add and blend the binder material when required with the aggregate surfacing to provide material meeting the specifications.

301.02.3 Blending Material. Blending material is selected natural or crushed mineral aggregate combined with the produced aggregate to meet specifications.

Do not use pit stripping's, overburden, or other deleterious material as blending material.

Furnish and add blending material to aggregate surfacing materials when required to meet gradation requirements.

The blending material must not increase the liquid limit and plastic limit of the surfacing material.

301.03 CONSTRUCTION REQUIREMENTS.

301.03.1 Sampling, Testing, and Acceptance.

A. **Production Control.** Develop a quality control sampling and testing plan for production and be responsible for all sampling and testing for gradation and mechanical fracture control during aggregate production.

B. **Acceptance Sampling and Testing.** The Project Manager will randomly select samples taken by the Contractor and witnessed by an inspector, for gradation, fracture, and cleanness value testing from processed material on the roadway under MT-201. Samples for other tests will be taken at the point of production.

The following acceptance tests are used:

Gradation	MT-202
Mechanical Fracture	MT-217
Cleanness Value	MT-228

The largest quantity represented by each sample is 2,500 tons (2267 mt) excluding cover material, which is 500 tons (453 mt). Additional samples may be selected and tested.

The quantity represented by 5 samples is a lot when production schedules and material continuity permit. The Project Manager may establish a lot consisting of a quantity represented by 3 to 7 consecutive random samples when there are short production runs, significant material changes, or other unusual characteristics of the work.

C. Acceptance. Surfacing aggregates are evaluated for gradation, mechanical fracture, and cleanness value on a lot-by-lot basis. The upper and lower limits in the Gradation Tables in Section 701 are the upper and lower limits in the evaluation formulas. The specified minimum fracture and cleanness values are the lower limit.

Acceptance is made under Subsection 105.03.2.

301.03.2 Equipment.

A. Rollers. Use rollers meeting Subsection 210.03.4 requirements.

B. Watering Equipment. Use watering equipment meeting Subsection 210.03.5 requirements.

C. Scales. Furnish scales meeting Subsection 109.01.1 or use certified permanently installed commercial scales. Furnish and have readily available at least ten 50-pound (22.7 kg) weights for testing contractor furnished scales. Furnish housing for the scale recording devices. Scale accuracy must be one-half of one percent at any weight.

Alternate weigh methods or devices may be acceptable, if they produce the required accuracy. Platform and belt-conveyor scale requirements are as follows:

1. **Platform Scales.** Use platform scales having the length to weigh an entire vehicle in an unbroken operation.

   Truck-trailer combinations may be weighed separately:

   a. If the scale approaches are compacted gravel or asphalt;

   b. Are long enough and level with the scale platform to accommodate the entire truck-trailer units;

   c. Are continually maintained.

   Release all brakes as the unit is weighed.

2. **Belt-Conveyor Scales.** Belt-conveyor scales may be used for non-asphaltic materials if the scale meets the general requirements for scales in Subsection 109.01.1 and the following:

   a. The scale meets the National Bureau of Standards requirements for belt-conveyor scales, except as modified below;

   b. A daily static-load test is made after approximately ½ hour of continuous belt conveyor operation and whenever the air temperature varies 15 °F (9 °C) or more. Have a calibration test performed once daily and whenever the daily static-load test shows adjustments are required;

c. Make calibration computations, calibration procedures and results, and related documents available for the Project Manager's review. Clearly mark test chains with calibration constants. Carry test chains and test weights in protective containers and make immediately available for belt-conveyor scale testing.

d. Perform accuracy checks by checking the average of 5 or more sequential payloads of hauling units on approved platform scales. The acceptable accuracy is plus or minus 0.5 percent of the payload of the average hauling unit. If the recording odometer of the belt-conveyor scales in use is graduated to 1/10-ton (200 lb) (91 kg) increments and is a cumulative recording process, differences in readings and variations less than 1/10-ton (91 kg) may carry over from one hauling unit to another. Conveyor weight conformation is based on the tonnage obtained from readings taken from the sealed odometer at the beginning and end of each check period. The number of check loads will be increased should the test results fluctuate.

Furnish a lock to secure the recording tape, odometer, totalizer, calibration adjustment, and clock-time imprinter. The Project Manager will lock the equipment and retain the keys before materials are delivered to the roadway.

301.03.3 Reject. Dispose of reject material produced from Department sources as directed.

301.03.4 Reserved

301.03.5 Aggregate Surfacing Construction.

A. Surface Preparation. Prepare the existing roadway surface meeting Section 204 immediately before placing surfacing material.

Do not place aggregate surfacing material on:

1. Any surface not meeting the dry density requirements for that surface;
2. A rutted or frozen subgrade or aggregate surface;
3. Any surface not meeting grade or surface smoothness specifications.

B. Pugmill Mixing. Pugmill mix all surfacing aggregates except crushed cover aggregate.

Uniformly mix aggregate surfacing and water in a central plant pugmill mixer. Proportion all blending material, filler, and binder by weight to within plus or minus one-half of one percent of the specified quantity before mixing.

Add the water needed to reach the specified density.

Additional water may be added only once to the aggregate surfacing once its placed on the roadway to replace moisture lost to surface evaporation. If additional water is needed, pick up the mixture and remix it in the pugmill.

1. **Placing.** Transport, place, and spread aggregate surfacing on the roadway immediately after mixing.

Spread in maximum 8-inch (205 mm) compacted layers to the required grade and typical section. Spot filling of low areas is prohibited.

C. Road Mixing. When specified, place, mix and spread the surfacing aggregates on approved surfaces at optimum moisture using motor graders or other approved equipment.

Water may be added to the aggregate to reach optimum moisture during or after crushing.

Once uniformly mixed, spread each layer of material to the specified typical section without causing segregation. Roller compact the spread layer.

Add binder only after it is approved for use.

Uniformly spread the binder over the loose spread surface course. Blend and mix binder uniformly into the surfacing material using approved methods and equipment.

For courses 3-inches (75 mm) thick or less, work the binder into the entire depth. For course depths exceeding 3-inches (75 mm), work the binder into the upper 3-inches (75 mm).

Correct or remove equipment from the work failing to maintain uniform gradation of the material for the entire width and thickness.

D. Compaction. Compact aggregate surfacing to 98 percent of the target density.

The initial target density is the average of the maximum density of at least two tests on samples representing the material to be compacted. Maximum density is determined by MT-230.

The Project Manager will take samples from the materials placed on the roadway. They will be tested and the results averaged with the previous tests to determine a new target density for the material remaining to be placed.

The Project Manager will establish a target density for each course, grade, and type of surfacing aggregate. A new target density will be established if the aggregate characteristics change.

Each lift of surfacing aggregate will be divided into 2000 foot long (610 m) sections. The in-place dry density of each lift is determined within each section at 10 randomly selected locations. The average of the 10 tests must exceed 98 percent of the target with not more than 2 out of the 10 tests being less than 98 percent of the target.

Be responsible for controlling compaction and all necessary control testing.

Notify the Project Manager once compaction is complete on a section so it may be tested.

Re-compact sections not meeting density requirements.

Re-compacted sections will be tested at 10 new random locations.

Compaction and testing will continue until the section meets density requirements.

Densities will be determined using MT-210, MT-212, MT-215, MT-218, and MT-230.

E. Trimming. Trim each course of compacted aggregate surfacing to the specified grade and section.

Use trimmings on the inslopes, on sections of uncompleted roadway or return to the pit area. When quantities are measured by the ton (metric ton), excess material returned to the pit are deducted from the pay quantities.

F. Restrictions. The Project Manager may restrict equipment speed and load weights to prevent damage to existing and new work, public thoroughfares or safety.

G. Surface Smoothness. Finish the aggregate surface to the specified grade within the following tolerances:

Aggregate Size	Tolerance	Distance
1-1/2"(40 mm) and larger	0.08 foot (24 mm)	30 feet (9.2 m)
1" and less (25 mm)	0.04 foot (12 mm)	60 feet (18.4 m)

301.04 METHOD OF MEASUREMENT.

301.04.1 Aggregate. Aggregate surfacing, blending material, fillers, binder, water, producing, handling, mixing, hauling, placing, spreading, compacting, trimming, use of trimmings, maintenance and all necessary incidentals to complete the work is measured by the cubic yard (cubic meter) or ton (metric ton), as specified.

When removing oversize surfacing material from the roadway, the oversize material is measured by the ton,(metric ton) returned to the aggregate source, and deducted from the total surfacing material placed on the roadway.

A. Measurement By The Ton. Aggregate surfacing is measured by the ton (metric ton) under Subsection 301.03.2(C).

Excess material removed from the roadway and returned to the pit area is deducted from the pay quantities.

B. Measurement By The Cubic Yard. Aggregate surfacing is measured by the cubic yard (cubic meter), under the applicable provisions in Subsection 109.01, from:

1. Plan dimensions; or
2. Haul vehicles; or
3. In-place roadway or stockpile volumes.

When measured in place, each course thickness of each grade of surfacing aggregate will be measured at random locations in a section. The section length and number of measurements is the Project Manager's discretion. The thickness measurements for each section are averaged and the average must equal or exceed the plan thickness. The minimum measured thickness at any location must be at least plan thickness less ½ the largest aggregate size permitted for the material.

Bring all sections of a completed course not meeting these specifications into compliance before placing the next course.

Aggregate surfacing for small or irregularly shaped areas ordered in writing by the Project Manager, are measured in the haul vehicle under Subsection 109.01.

Aggregate surfacing to fill in subgrade low areas or placed outside the lines and slopes shown in the plans or established by the Project Manager is not measured for payment.

301.04.2 Binder. Binder added at the crusher plant is included in the measurement for the aggregate material.

Binder added to the surfacing material once placed on the roadway is measured by the cubic yard (cubic meter) or ton (metric ton) under Subsection 301.04.1(A) or (B).

When specified as a contract item, haul on binder is measured by the mile-yard (kilometer-cubic meter) or ton-mile (ton- kilometer) under Subsection 206.04.2.

When not specified as a contract item, haul on binder is not measured for payment.

301.04.3 Existing Surface Preparation. When specified, existing surface preparation is measured under Subsection 204.04.

When existing surface preparation is not specified, it is incidental to and included in Aggregate Surfacing.

301.04.4 Aggregate Haul. Aggregate haul is not measured for payment unless specified. If specified, it is measured under Subsection 206.04.2.

301.04.5 Compaction. Compaction is incidental to Aggregate Surfacing.

301.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Aggregate	Cubic Yard (cubic meter) or Ton (metric ton)
Binder	Cubic Yard (cubic meter) or Ton (metric ton)
Binder Haul	Mile-Yard (kilometer-cubic meter) or Ton-Mile (metric ton-kilometer)
Existing Surface Preparation	See Subsection 204.05
Aggregate Haul	Ton-Mile (metric ton-kilometer) Mile Yard (kilometer-cubic meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 303
STOCKPILED SURFACING AGGREGATE

303.01 DESCRIPTION. This is stockpiling surfacing aggregates at the specified location.

303.02 MATERIALS. Furnish materials meeting Subsection 301.02 and the contract requirements.

303.03 Aggregate Stockpiling Methods. Clear stockpile sites of weeds, roots, stumps, rocks, and other contaminating matter. Dispose of this material under Subsection 201.03.5 (B) or level as directed.

Make the stockpile floor firm, smooth, well drained, uniform in cross section, and able to support the stockpile.

Place an aggregate bed on the floor to prevent stockpile contamination.

Construct stockpiles in at least 3 layers. Place each layer approximately 4 feet (1.2 m) high before starting the next layer. Prevent each layer from spilling down over the next lower tier.

Do not drop material stockpiled by conveyor more than 12 feet (3.7 m). Deposit the material in succeeding merging cone piles. Do not permit the piles to exceed 12 feet (3.7 m) in height. Level each completed layer to 4 feet (1.2 m) thick.

Operate stockpiling trucks to produce a stockpile width that exceeds the single dump trucks width. Do not dump over the stockpile sides.

Maintain separation between different gradation stockpiles to prevent aggregates from intermingling.

Use equipment and methods to prevent segregation, degradation, or contamination of the aggregate when constructing stockpiles or delivering materials.

Department sieve test samples will be taken from the stockpile to determine degradation.

Re-mix and re-stockpile segregated stockpiles.

Bring stockpiled material failing specifications back within specifications at Contractor expense.

303.04 METHOD OF MEASUREMENT.

303.04.1 Aggregate. Stockpile surfacing aggregate is measured at the stockpile site by the ton (metric ton) or cubic yard (cubic meter) under Subsection 301.04.1.

303.04.2 Haul. Haul is measured under Subsection 206.04.2.

303.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Aggregate	Ton (metric ton) or Cubic Yard (cubic meter)
Haul	Ton Mile (metric ton/kilometer) or Mile Yard (kilometer/cubic meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 304
PORTLAND CEMENT TREATED BASE

304.01 DESCRIPTION. This work is the construction of one or more courses of an aggregate, water, and portland cement mixture on a prepared surface.

304.02 MATERIALS.

304.02.1 Portland Cement. Use portland cement meeting AASHTO M 85, Type I or Type II requirements.

304.02.2 Water. Use water meeting Subsection 713.01 requirements.

304.02.3 Aggregate. Use aggregate source(s) meeting Section 106 requirements.

Produce aggregates meeting Subsection 701.02.9 requirements.

Assure aggregate is available for sampling at least 60 days before mixing is to begin.

Stockpile the aggregates under Subsection 303.03.

304.02.4 Blending Material. Blending material, consisting of selected natural or crushed mineral aggregate may be combined with the produced aggregate and added to meet gradation requirements. Blending material is by and at Contractor expense. The liquid limit for that portion of the fine aggregate passing the No. 40 (0.425) sieve cannot exceed 30, and the plasticity index cannot exceed 7, tested under MT-208.

304.03 CONSTRUCTION REQUIREMENTS.

304.03.1 Composition and Proportioning.

A. **Cement.** Add portland cement at the job mix target rate set by the Engineer. The initial job mix target rate is the laboratory mix design value.

B. **Water.** Provide the water to reach plus or minus two percent of the optimum moisture content of the compacted mixture.

C. **Aggregate.** Establish a single value for each specified aggregate size within the job-mix target limits in Table 701-13 in Subsection 701.02.9 as the target aggregate gradations. Submit it to the Engineer for approval. The job mix tolerances will be applied to the approved target values for final acceptance.

Produce aggregates meeting the approved job-mix aggregate gradation.

304.03.2 Aggregate Production, Testing, and Acceptance.

A. **General.** Perform all work to meet the approved job-mix target values within the specified tolerances.

Sample and test aggregates during production to control gradations.

B. Acceptance Sampling and Testing. The Department will sample the stockpiles for acceptance of the aggregates physical properties, excluding combined gradations. Aggregate gradation samples for acceptance testing are randomly taken at the last practical point before portland cement and water are added to the mixture.

The approximate quantity represented by each sample is 1500 tons (1350 t).

Additional samples will be taken as necessary.

Five samples will represent approximately 7500 tons (6750 t) which constitutes a lot whenever production schedules and material continuity permit. The Project Manager may establish a lot of the quantity represented by any number of consecutive random samples from 3 to 7 inclusive when there are short production runs, significant material changes, or other unusual characteristics of the work.

C. Acceptance. Cement-treated base is evaluated for gradation requirements on a lot-by-lot basis. Acceptance is made under Subsection 105.03.2

304.03.3 Weather Limitations. Do not mix or place cement-treated base when the ambient temperature is below 40 °F (4 °C) or when the local weather forecast predicts the temperature to fall below 35 °F (2 °C) within 24 hours. The Project Manager will determine which forecast applies to the project.

Do not incorporate frozen aggregate in the cement treated base or place it on a frozen subgrade.

304.03.4 Subgrade Preparation. Prepare the subgrade meeting the applicable requirements of Section 203. Do not place the cement treated base on a soft or yielding subgrade.

Place cement-treated bases on constructed subgrades with the existing surface preparation meeting Section 204 requirements.

Trim the subgrade to the thickness tolerances for cement-treated base specified in Subsection 304.03.13.

304.03.5 Mixing. Mix the Portland cement-treated base in a central plant.

Proportion the aggregate and cement by weight. Water may be proportioned by weight or by volume.

Assure weigh systems and meters are accurate to within plus or minus 0.5 % of the total quantity batched and are equipped to indicate the total quantity of each ingredient batched between one half to ten hours.

Calibrate the feed system before production mixing begins.

Mix ingredient proportions will be periodically verified from the weigh indicators.

Maintain the cement content to within plus or minus 1.0% of the job mix target at any periodic check and within plus or minus 0.3 % for each day's production. Mixing will be suspended if the Contractor fails to maintain cement content within the above tolerances until corrections are made.

Uniformly mix aggregate, cement, and water. Modify mix procedures when evidence of a non-uniform mix is identified.

304.03.6 Moisture-Density Test. The moisture and density relationship is determined by Montana Test Method MT-211 using samples taken from the aggregate stockpiles before starting mixing operations.

Once cement-treated base production has begun, subsequent moisture-density tests will be made on samples taken from the roadway to verify the moisture-density relationship obtained from the stockpile samples.

The compacted minimum density is 96% of the maximum dry density as determined above.

304.03.7 Compaction. Select the compaction method and complete compaction within two hours after mixing.

Field density values are determined under MT-212. One density test is taken at a randomly selected site within a 500 foot (152 m) section being constructed. If the density is below that specified, two additional tests will be taken in that section and the results averaged. The average density for the 3 tests must be at least the specified density, with none of the 3 tests less than 93% of the maximum dry density.

If the densities do not meet the specified requirements, remove the mix and reconstruct the section at Contractor expense.

The removed mix may be re-processed as aggregate for producing cement-treated base.

Remove and re-process any un-compacted sections where the weather has increased the average moisture content above optimum by more than 2%.

304.03.8 Finishing. Shape the compacted surface to the specified lines, grades, and cross sections.

Finish and compact to produce a smooth, dense surface free of compaction planes, cracks, irregularities, or loose material.

Complete the surface finishing within two hours of compaction.

Scarify and re-compact surface deformations in the base caused by equipment.

Do not permit the moisture content to fall below the specified optimum during finishing. Apply water in a uniform fog spray.

304.03.9 Construction Joints. Construct straight vertical-faced transverse joints at the end of each day's work by cutting back into the completed base. Assure the vertical face is free of loose material.

Repair all construction related damage to finished sections of the cement-treated base at Contractor expense.

304.03.10 Protection and Curing. Once the cement-treated base is finished, apply the specified bituminous curing seal at approximately 0.2 gallon per square yard (0.91 L per m^2).

Keep the cement-treated base surface moist between the final compaction and application of the curing seal.

Before applying the curing seal, assure the base surface is tightly knit, free of all loose material, and has sufficient moisture to prevent asphalt penetration.

Apply the specified blotter material at approximately 15 pounds per square yard (8.2 kg per m^2) when directed.

The actual application rate of curing seal and blotter may be adjusted by the Project Manager.

Remove base areas that have absorbed the curing seal down to hard, clean base, within 24 hours of application. Re-moisten if requested and re-apply the curing seal as specified.

Apply the curing seal and blotter material meeting the applicable requirements of Section 409.

304.03.11 Curing Period. Allow the cement-treated base to cure for at least 7 days after the curing seal is applied before applying the wearing course.

Immediately repair all curing seal damage during the cure period at Contractor expense.

304.03.12 Maintenance. Maintain the finished surface and seal before placing the wearing course. Make all repairs or patches the full depth of the base.

304.03.13 Surface Smoothness and Thickness Requirements.

A. Surface Smoothness. Assure the final surface does not vary from the mean constructed grade by more than nor diverge from the mean constructed grade at a rate exceeding the following:

Total Variation	Rate
0.04 foot (12 mm)	0.40%

Mean constructed grade for each section is the planned grade or a grade approximately parallel to plan grade, as determined by the Project Manager.

Correct all out of tolerance surface irregularities within 12 hours of compaction and finishing using a motor patrol.

B. Thickness. The finished cement-treated base thickness is determined by drilling test holes at random locations within 500 feet (152 m) sections. The average thickness constructed in one day must be more than plan thickness minus 5%, with no individual measurement less than plan thickness minus 10 percent.

Re-construct areas at Contractor expense where:

1. The average thickness represented by one day's construction is outside the specified tolerance; or
2. In limited areas that vary in thickness in excess of 10% from the plan thickness.

304.03.14 Use of Trimmed Material. Cement-treated base trimmings may be used for shoulder construction in lieu of aggregate, subject to the following:

1. The shoulder subgrade is prepared as specified in Subsection 304.03.4;
2. Hardened material is reworked to the maximum size specified for shoulder aggregate before spreading additional shoulder aggregate;
3. The trim material used cannot exceed 25% of the contract aggregate shoulder depth per linear foot (305 mm) of shoulder. When trimmings

exceed this limit, remove or place the excess in other shoulder areas, subject to the 25% limit;

4. Uniformly distribute the trim material in the shoulder area before spreading additional shoulder aggregate.

304.04 METHOD OF MEASUREMENT.

304.04.1 Cement-Treated Base. Cement-treated base is measured by the square yard (square meter) of completed surface.

Cement-treated base placed outside the lines shown in the Contract or established by the Project Manager is not measured for payment.

No measurement is made of the width required for forms or equipment operations.

Gravel used in trimmings and lateral support sections outside the planned typical section dimensions are not measured for payment.

304.04.2 Portland Cement. Portland cement is measured by the short ton (metric ton) or by the hundredweight (kilogram) under Subsection 109.01.

Measurement includes the cement in trimmings used as shoulder gravel.

Additional cement required for the re-processing specified in Subsection 304.03.7 is not measured for payment.

The payment weight is the invoice weight, up to the job mix target quantity, plus 0.3 percent. Furnish copies of invoices showing weights from certified scales.

Deductions are made for waste and non-project use.

304.04.3 Curing Seal. Curing Seal is measured by the gallon (liter) or by the ton (metric ton) under Subsection 409.04.1.

304.04.4 Blotter Material. Blotter material is measured by the ton (metric ton) or by the cubic yard (cubic meter) for the quantity applied and accepted in place.

304.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Cement-Treated Base	Square Yard (square meter)
Portland Cement	Short Ton (metric ton) or Hundredweight (kilogram)
Curing Seal	Gallon (liter) or Ton (metric ton)
Blotter Material	Ton (metric ton) or Cubic Yard (cubic meter)

Existing Surface Preparation is measured and paid for under Subsections 204.04 and 204.05.

Payment at the contract unit price is full compensation for all necessary resources to complete the item of work under the Contract.

SECTION 401
PLANT MIX PAVEMENT

401.01 DESCRIPTION. This work is the production and placing of plant mix asphalt pavements.

Plant mix pavement is one or more courses of plant mixed aggregate, mineral filler or chemical additive when required, and bituminous material, constructed on a prepared foundation.

401.02 MATERIALS.

401.02.1 Aggregate. Use aggregate sources meeting Section 106 requirements. Produce aggregate meeting Section 701 requirements.

401.02.2 Bitumen. Furnish bitumen meeting Section 702 and the Contract requirements.

401.02.3 Blending Material. Blending material is selected natural or crushed mineral aggregate.

Do not use pit stripping's, overburden, or other deleterious material as blending material.

Furnish blending material with a volume swell not exceeding 8 percent and not displaying cracking or disintegration when tested under MT-305.

401.02.4 Mineral Filler. Furnish mineral filler meeting Subsection 713.06 requirements.

The mineral filler quantity and type is determined by tests made with mineral fillers in the crushed aggregate for plant mix bituminous material.

401.02.5 Additives.

A. Hydrated Lime. Furnish hydrated lime meeting Subsection 713.02 requirements. Hydrated lime introduced into a paving mixture, in a blend box with asphalt cement, is a chemical additive and is not included in gradation test results.

B. Anti-Stripping Additive. Furnish anti-stripping additives meeting the contract requirements.

The percentage of anti-stripping additive is determined by laboratory tests on samples of the aggregate proposed for use. The anti-stripping additive must be uniformly distributed throughout the bituminous material at the refinery.

The anti-stripping quantity may be increased or decreased by the Engineer.

401.03 CONSTRUCTION REQUIREMENTS.

401.03.1 Composition of Mixtures.

A. Job Mix Formula - Design. Develop and submit for approval, a proposed job mix target aggregate gradation for each grade of pavement mix to be

produced. Establish a single target value for each specified aggregate size within the Job Mix Target Limits in Table 701-15 of Subsection 701.03. The job mix tolerances will be applied to the approved target values. Submit the proposed job mix formula on Form CB-30 QA before submitting the mix design samples.

Furnish aggregate samples, witnessed by the Department, representing total production at least 20 days before mixing operations. The Department will establish for each mixture a design mix formula providing the approved job mix aggregate gradation, a recommended asphalt content, and the types and quantities of additives, if required.

Produce aggregates meeting the approved job mix aggregate gradation. This procedure will be repeated if there is a change in the aggregate properties or a change in the materials source.

B. **Job Mix Formula - Field Established.** A job mix formula for each grade of bituminous mix will be established in the field for each design mix formula.

The Engineer will establish a target asphalt content expressed as a percentage of the total mix weight. The target asphalt content is based on design and field Marshall mix test results. The target asphalt content may be adjusted to improve mix properties as measured by field Marshall tests. Maintain the actual asphalt content in the mix within plus or minus 0.3 % of the target asphalt content.

Use the approved job mix aggregate gradation unless otherwise directed.

C. **Aggregate Sampling and Acceptance.** Aggregate is accepted in the stockpiles for physical properties, excluding combined gradation.

Take samples, witnessed by the Department, for aggregate gradation acceptance testing, just before the bitumen is added to the mix.

When aggregate gradation is controlled by a cold feed control system without plant screens, acceptance testing samples may be taken from the cold feed. Cold feeds for batch plants will not be sampled for acceptance testing when plant screens are used.

401.03.2 Equipment.

A. **All Mixing Plants.** Furnish bituminous mixing plants meeting the following requirements. Scale requirements apply only where proportioning by weight is required. Cold feed control requirements apply only where aggregate gradation is controlled by a cold feed control system.

1. **General.** Use mixing plants of the weight-batching, continuous-flow, or dryer drum type.

   Do not use mixing plants that cannot produce a uniform mix meeting the Contract requirements.

2. **Storage and Heating Equipment.** Use bitumen storage tanks that uniformly heat and maintain the tank contents at the required temperatures.

   Do not allow fuel oil or other material to contaminate the bitumen.

   Equip storage tanks with a gauge, calibrated rod, or float that accurately measures the contents.

3. **Aggregate Feeder.** Equip plants with an accurate, mechanical aggregate feed system.
4. **Bins.** Provide easy and safe access to bins and bin sampling areas. Provide separate, dry storage for the mineral filler.
5. **Bituminous Control Unit.** Use weighing or metering devices to control the bituminous material introduced into the mix within the specified limits.

   Measure the bitumen discharged into the mixer by a temperature-compensating meter with totalizer.
6. **Thermometric Equipment.** Install an armored thermometer or other approved thermometric device in the bituminous material feed line near the charging valve at the mixer.

   Use thermometric equipment having an accuracy of plus or minus 5 °F (3 °C), sensitive to a minimum temperature rate change of 10 °F (5.5 °C) per minute.
7. **Emission Control.** Furnish emission control devices meeting the Department of Health and Environmental Sciences requirements.

   Do not discharge wet scrubber effluent into a live stream, lake, or pond. Circulate the effluent through sludge pits or tanks. Contain and dispose of the sedimentation, and all other wastes produced by crushing and mixing operations under Subsection 106.02.5.

   Do not return the material collected from air pollution control equipment (bag house fines) to the mix unless authorized in writing. Authorization may be terminated when test results indicate any mix property is outside the specified limits. When authorized, return bag house fines to the mix where the asphalt is introduced, using equipment to meter and uniformly add as a percentage of the total aggregate as established by the Engineer.
8. **Scales For Hauling Units.** Furnish haul unit scales meeting Subsection 301.03.2© requirements.
9. **Plant Scales.** Obtain the Engineer's approval for all weighing equipment. Use adjustable weigh equipment accurate to within 0.5 percent of the true weight throughout the use range.

   Have available at least ten 50-pound (22.7 kg) weights for scale testing. Have scales inspected and sealed when requested.

   Use beam scales with a telltale indicator for each size aggregate and a tare beam for balancing the hopper. The telltale indicator must begin moving when the weight is within 100 pounds (45.4 kg) of the desired weight. Poises must lock in any position and prevent unauthorized change.

   Use vibration-free springless dial scales with dial numerals legible from a distance of at least 10 feet (3 m). The dial must be a compounding type with a full complement of index points and be in plain view of the operator. Pointers causing parallax errors cannot be used.

   Replace scales failing to maintain positive adjustment.

10. Weigh System.

a. Automatic Weighing. Plant mix bituminous mixtures may be weighed with an automatic digital weigh system. Assure weigh accuracy to within plus or minus 0.5 percent of the true weight throughout the use range.

Include in the system an automatic printer that provides the following information:

1. Project No. (as shown on plans)
2. Item Name (as shown on detail estimate)
3. Date
4. Time
5. Ticket Number (consecutive)
6. Haul Unit No.
7. Net tons (metric ton) in load (to nearest 0.05 ton)
8. A subtotal of tons (metric tons) for each haul unit since the beginning of the shift.
9. An accumulated total for all haul units since the beginning of the shift.

Use a pre-programmed printer or one equipped to prevent manual override of any weight information. Have the weigh system tested, certified, and sealed by the State Bureau of Weights and Measures after each plant move and before production for a project. Immediately stop production should the printer malfunction or breakdown and do not resume until corrected. Delivery of material from storage or surge bins will be permitted only if the weight can be maintained within weigh specifications.

The Project Manager will randomly designate the re-weighing of loaded vehicles, at least 3 times per project, on a independent certified scale if one is within a 20 mile (32 km) round trip distance from either end of the project.

Re-test the plant weigh system any time the difference between the re-check and the plant system exceeds plus or minus 1½% of the load. Any weight difference will be treated under Subsection 109.01.1.

b. Manual Weighing. The Contractor may manual weigh and record weights instead of using an automatic digital weigh system. Manual weighing must include platform scales as specified in Subsection 301.03.2© and a competent weigh person and dump person.

Direct the weigh person to record, on Department furnished forms, weights to the nearest 100 pounds (45.4 kilograms) as well as other required information regarding delivery and placement.

Tabulate and furnish a machine tape for the total of the weighed material delivered and placed on the roadway each shift. Certify that weights and totals furnished are a true and correct record of materials delivered and placed in the work. Deliver the records and totals to the Project Manager before 10:00 a.m. the next working day following the shift.

The Project Manager will randomly designate the re-weighing of loaded vehicles to verify the recorded weight at least once each day. Weight differences are treated under Subsection 109.01.1. Submit trucks weighing on platform scales for random taring at least twice each day.

11. **Safety Requirements.** Install and maintain stairs, ladders, walkways, and all other plant facilities meeting State and Federal safety requirements.

    Provide access to the tops of truck bodies for taking samples and mix temperature data.

    Maintain a safe and unobstructed route in and around the truck loading area.

12. **Cold Feed Control.** Aggregate gradation may be controlled by a cold feed control system permitting hot mix plant operation without plant screens, excluding a scalping screen.

    Feed each aggregate stockpile through a separate bin having a positive feed that can be accurately calibrated. Use a quick-adjusting feed that maintains a constant, uniform flow throughout its calibration range.

    Re-combine the aggregate in the mix design proportions in the cold feed process before it enters the dryer.

    Batch and continuous flow plants operating without cold feed controls must have enough bins to store aggregate and permit recombining of the aggregate in the required proportions.

13. **Burner Fuel Restrictions**. Approved fuels to heat and dry aggregates are as follows:
    1. Propane
    2. Butane
    3. Natural Gas
    4. Fuel Oil (grades 1 and 2 only)
    5. Coal

B. Batching Plant.

1. **Dryer.** Furnish plants having a dryer or dryers that continuously agitate the aggregate while heating and drying.

   Equip the dryer with a mercury-actuated thermometer, an electric pyrometer, or other approved thermometric instrument with a dial scale. Locate the thermometer at the dryer discharge chute so it automatically registers the heated aggregate temperature.

   Fully enclose the material transfer or conveyance from the dryer to the mixer.

2. **Screens.** Use plant screens that have a storage capacity exceeding the mixing units full capacity.

3. **Bituminous Control.** Assure the bituminous measuring equipment is accurate to within plus or minus 0.3 percent of the true measure.

   Equip the plant with a heated, quick-acting, no-drip charging valve located directly over the bituminous material bucket. The bucket must deliver the heated bitumen in a thin, uniform sheet or in multiple streams over the mixing units full width.

4. **Mixer Unit.** Use a mixer capable of producing a uniform mixture within the job-mix tolerances.

   Enclose or hood the mixer box to prevent dust loss.

   Equip the mixer box with a lock timing device that controls the mixing cycle.

5. **Aggregate Sampling Device.** Provide a sampling device that will sample dried aggregate when the plant is operated with plant screens.

   When cold feed controls are used, provide a sampling device for taking a composite sample at a point just before the aggregate enters the dryer.

   Maintain a constant aggregate feed rate when samples are taken.

   Split the sampled material to the size specified in MT 202.

C. Continuous Mixing Plant.

1. **Aggregate Control.** Assure the cutoff system automatically stops mixing when the minimum bin level is reached. Equip each bin with an overflow to control the top aggregate level.

   Equip the plant with bypass gates for collecting individual box test samples for calibrating gate openings.

   Provide a platform scale with a 500 pound (227 kg) capacity and containers for weighing test samples.

2. **Dryer.** Furnish a dryer meeting Subsection 401.03.2(B)(1) requirements.

3. **Screens.** Furnish screens meeting Subsection 401.03.2(B)(2) requirements.

4. **Bituminous Control.** Use a rotating, positive-displacement volumetric proportioning bituminous metering pump with nozzles at the mixing unit. The pump operating capacity must be synchronized with the aggregate flow to the mixing unit by a positive, automatic, adjustable interlocking control. Provide equipment for accurately checking the bitumen flow rate into the mix.

5. **Mixing Unit.** Equip the plant with a continuous mixer to produce a uniform mix within the job-mix tolerances.

   The units paddles must be adjustable and reversible to retard the mix flow. Assure the mixer has the manufacturer's plate stating the mixer's net volumetric content at the heights inscribed on a permanent gauge. Provide charts showing the aggregate feed rate per minute for the aggregate being used.

   Equip the discharge hopper with dump gates that permit rapid and complete mix discharge.

6. **Aggregate Sampling Device.** Furnish a aggregate sampling device meeting Subsection 401.03.2(B)(5) requirements.

D. Dryer Drum Mixing Plant.

1. **Cold Feed Control.** Furnish a feed control meeting Subsection 401.03.2(A)(12) requirements.

2. **Calibrated Cold Feed Proportioning.** Calibrate the cold feed to provide full mix gradation control.

3. **Weight Measurement of Aggregate.** Positive weight measurement of the combined cold feed must regulate the feed gate and permit automatic correction for load variations.
4. **Synchronization of Aggregate Feed and Bituminous Material Feed.** Synchronize the bituminous feed control with the total aggregate weight-measurement device to provide a uniform asphalt percentage in the mix. It must automatically compensate for weight variations in the cold feed coupled with the aggregate moisture content.
5. **Aggregate Sampling Device.** Provide a sampling device that will take a composite sample just before the aggregate enters the dryer drum mixer.

   Maintain the aggregate feed rate during sampling. Split the sampled material to between 30 (13.6 kg) and 50 pounds (22.7 kg).
6. **Hydrated Lime or Mineral Filler Feed System.** Introduce dry hydrated lime and mineral filler into drum dryer mixing plants just below the asphalt introduction point.

   The system must provide positive, accurate material feed and be automatically synchronized to the aggregate feed. The system must indicate the weight entering the mixing unit on a time coordinated basis.

   Weigh using an automatic indicating electronic system. The lime or mineral filler may be weighed directly, or the storage container including lime or mineral filler may be weighed.

   Provide a continuous digital readout showing the weight or rate of feed in tons (metric tons) per hour. Record the information using a production monitor/recorder system or by a de-cumulating balance ticket printing system. Record the information at minimum five minute intervals or as directed.

   Silo or storage container system weights will not be used for acceptance during filling or transfer. Limit filling or transfer periods to 1 hour per 3 hours of plant operation. Record and provide start and finish times for filling or transfer and the total quantity added.

   Suspend mixing for erratic feeding or failure to feed hydrated lime or mineral filler to within 20 percent of the job mix formula. Do not resume until corrected or repaired.
7. **Flow Rate Meter.** Measure the asphalt cement discharged into the mixing unit using a flow rate meter with totalizer and temperature compensation.

   The totalizer is to record 1,000,000 gallons (3,785,000 L) and be certified to a plus or minus 0.20 percent of the measured quantity.

   Use a flow rate meter and totalizer that automatically corrects to a temperature of 60 °F (16 °C) with an operating range of +60 °F (16 °C) to +450 °F (232 °C).

   Locate the totalizer readout in the plant control room so it is readily accessible to the inspector.

   The flow rate meter must automatically shut off any time asphalt is diverted or stops entering the mixing unit.

Calibrate the flow rate meter and totalizer before the start of the project and as necessary during production. The Project Manager will witness the calibration.

Provide the equipment and assistance for initial and subsequent calibration checks and furnish the Project Manager a copy of all calibration checks.

Use a calibration volume of at least 3,000 gallons (11,355 L). Use weigh scales that have been tested and certified.

Furnish a test report showing the asphalt's specific gravity.

Spot check failure will require re-testing and certification above. The Project Manager will establish the spot check interval.

8. **Production Monitor-Recorder.** Use recording equipment that automatically monitors and records on a time coordinated basis, the aggregate, lime or mineral filler, and asphalt weight entering the mixing unit. The records may be continuous (chart recorder) or digital printout.

Chart recorders must clearly record asphalt content changes of 0.1 percent or more and aggregate feed rate changes of 1.5 percent or more.

Digital printout equipment must record the day's total production at minimum five minute intervals, or the interval directed by the Project Manager.

Digitally display the aggregate and asphalt rates in tons (metric tons) per hour and daily totals. Display lime or mineral filler by tons (metric tons) per hour or on a de-cumulating balance.

The monitor system must operate on unprocessed signals from measuring devices.

Provide the Project Manager continuous access to the recorder during production.

Submit the permanent record to the Project Manager daily.

Failure to maintain asphalt content within the specified tolerance is grounds to suspend production until corrected. This provision does not apply to the first 15 minutes after each day's first start-up.

Operate the production/monitor recorder at all times during production. Stop production when the recorder is not operational.

E. Storage and Surge Bins.

1. **General.** Hot bituminous mix storage or surge bins may be used for balancing production capacity with hauling and placing capacity.

Discontinue use of hot mix storage or surge bins that cause segregation, adverse mix heat loss, or adversely affects the bituminous mix quality.

Dispose of all rejected mix at Contractor expense.

2. **Low-Level Indicator.** Equip storage or surge bins with an automatic low level indicator that signals when the mix level drops below the discharge cone or the minimum level specified by the manufacturer.

Mix discharge during low level indication is permitted for emptying the bin at the end of shifts.

3. **Loading and Unloading.** Equip storage or surge bins with a batch hopper or rotating chute to reduce segregation during loading. The

batch hopper gates must be interlocked with the mix discharge gates to keep the batch gates closed during mix discharge. Suspend production for equipment failure or improper operation.

4. **Storage Time.** The Project Manager will establish the maximum bin storage time. Initially, a maximum bin storage time of two hours without discharge is permitted until data and experience is available to establish the maximum permissible storage time.

   Empty all bins each day at the close of work.

F. Roadway Equipment.

1. **Pavers.** Spread plant mix pavement, shape, and finish using one or more self-contained, self-propelled pavers operated without supplemental spreading, shaping, or finishing equipment to produce the specified work.

   Equip pavers with an integral activated screed or strike-off assembly, heated if necessary.

   Spread and finish the surfacing course to at least a full lane width and from 3/4 (19 mm) to 6-inches (150 mm) in depth.

   Use extension and cut-off shoes in minimum 1 foot (305 mm) increments. Screed extensions must have an equal length of auger extension.

   The screed or strike-off assembly must not tear, shove, or gouge the paved surface.

   Equip pavers to automatically control the transverse slope and screed elevation using a sensing device at either side of the paver, receiving grade information from an independent grade-line control or the midpoint of a mobil grade reference.

   Mount the sensing unit to receive grade information at 15 to 50 percent of the length of the leveling arm ahead of the screed. Furnish a commercially manufactured mobile grade reference recommended by the paver manufacturer.

   Use a mobile grade reference device at least 40 feet (12.2 m) long to place the first lane or strip of each plant mix pavement lift. The remaining lanes or strips of each pavement lift may be placed with a mobile grade reference with an effective length of at least 10 feet (3 m), with an adjacent lane or pavement strip as the gradeline reference.

   Maintain the transverse slope at all times and have controls to adjust the slope throughout super-elevated curves.

   If the automatic controls fail, paving may be finished, not to exceed 4 hours, using manual controls, if the specifications can be met. Repair the automatic controls before starting the next paving shift. Automatic controls may be waived on irregular sections.

   Provide an attachment for forming beveled edges on surfacing courses when required.

   Pavers must be able to ascend a 7% grade while pushing a loaded truck, have quick, positive steering and operate at speeds commensurate with the mix delivery rate to allow uniform placement and prevent interrupted paver operation.

The plant mix material may be dumped directly into the paver hopper or windrowed ahead of the paver.

The paver hopper capacity must permit the paver to maintain its speed while receiving loads.

2. **Trucks.** Truck haul beds must be tight, clean, smooth and free of cleaning agents before hauling material.

   Do not use trucks that cause segregation, delays, or have oil leaks.

   When directed, cover each load with canvas or other approved material to protect the mix.

3. **Rollers.** Furnish rollers equipped with drum cleaning devices and a watering system that evenly wets the roller surface.

   Do not use steel rollers having flat spots, grooves, or projections that mar or injure the pavement surface.

   Remove rollers that crush the paving aggregates.

401.03.3 Aggregate Production, Testing, and Acceptance.

A. **General.** Furnish aggregates meeting the approved job mix target values within tolerances at the point of bituminizing.

Be responsible for all sampling, testing and controlling aggregate gradations, mechanical fracture, and volume swell during aggregate production. Establish a quality control plan using generally recognized procedures.

B. **Acceptance Sampling and Testing.** Acceptance sampling will be by Subsection 401.03.1(C).

1. **Mechanical Fracture and Volume Swell.** Mechanical fracture tests will be by MT-217. Volume swell tests will be by MT-305.
2. **Aggregate Gradation.** The Project Manager will randomly select gradation test samples.

   The approximate quantity represented by each sample will be 600 tons (540 mt). Additional samples may be selected and tested at the Project Manager's discretion.

   The quantity represented by 5 samples or approximately 3000 tons (2700 mt) will constitute a lot whenever production schedules and material continuity permit. The Project Manager may establish a lot quantity represented by 3 to 7 consecutive random samples when there are short production runs, significant material changes, or other unusual characteristics of the work.

   Gradation tests will be by MT-202.

C. **Acceptance.**

1. **Fracture and Volume Swell Requirements.** The aggregate will be evaluated for mechanical fracture and volume swell requirements using the test results taken on samples selected by the Project Manager.

   Results are acceptable if the average of all tests is within the specified limits and not more than one test out of any five consecutive tests is outside these limits.

   Do not begin plant mix operations until stockpiled aggregates meet these requirements.

2. **Gradation Requirements.** Plant mix pavement is evaluated for gradation requirements on a lot-by-lot basis. Acceptance is made under Subsection 105.03.2

401.03.4 Preparation of Aggregate.

A. General. Have enough material stockpiled for at least one day of plant mix operations.

Do not charge the mixing plant with aggregates directly from crushing or screening plants or a combination of these plants.

Proportion and uniformly blend blending material (not mineral filler), when required, with the aggregate.

B. Batch and Continuous Flow Plants. Dry and heat aggregates in the dryer within the mix design temperature range.

The aggregate temperature, when introduced into the mixing unit, must not exceed 325 °F (163°C).

Adjust flames for drying and heating to prevent aggregate damage and not leave visible unburned oil or carbon residue on the aggregate.

If the bituminized mixture shows excess moisture, such as foaming on the coarse aggregate, excessive mix slumping in the truck, condensed water dripping from the truck box, bubbles or blisters forming on the surface immediately behind the paver, or any other visual indications, make adjustments to lower the moisture content.

401.03.5 Preparation of Bituminous Mixture.

A. All Plants. Store mineral filler or hydrated lime in a separate bin and feed directly into the mixing unit or weigh box. Use a uniform feed rate.

If mineral filler is not weighed with the other aggregates in the weigh box at the mixing plant, determine the mineral filler proportion on a weight basis, measured separately from the other aggregates. After the mineral filler proportions have been determined, the material may be added to the mix by volume or weight measurement.

Mix to produce a homogeneous mixture. Assure all aggregates are thoroughly and uniformly coated with bitumen.

Remove, dispose of, and replace any mix that is damaged by burning, improper mixing, or not meeting specifications at Contractor expense.

Maintain the bituminous mix discharge temperature between the specified lower mixing temperature and the greater of:

1. The upper mix design temperature; or
2. 325 °F (163 °C).

The discharge temperature will be periodically checked and recorded. Maintain a discharge temperature within plus or minus 10 °F (5.5 °C) of the specified temperature.

The average of any three checks must be within the specified limits. Suspend plant operations when mix temperatures exceed these limits.

B. Batch and Continuous Flow Plants.

1. **General.** Measure and convey the hot aggregate into the mixing unit meeting the specified gradation. Introduce the aggregate at a temperature:
   a. Not to exceed 225 °F (107 °C) when cutback liquid asphalt is used;
   b. Not to exceed 325 °F (163 °C) when asphalt cement or slow-curing liquid asphalt is used.

   Do not introduce asphalt into the mixing unit at 25 °F (14 °C) or more below the aggregate temperature.

   Assure the bituminous mix is within the specified temperature range in the data on "temperature-viscosity", furnished for the bituminous material used.
2. **Mixing Time.** Mix for at least 25 seconds or the time specified by the Project Manager.

   Mixing time, in seconds, for continuous flow plants equals "pugmill dead capacity in pounds (kilograms)" divided by "pugmill output in pounds (kilograms) per second".

401.03.6 Surface Conditions, Weather Limitations, and Paving Dates. Do not place bituminous mix when the base surface temperature is less than 30 °F (-1.1 °C); on a wet surface; on an unstable roadbed; or when the Project Manager determines adverse weather conditions prevent the proper handling, finishing, or compacting of the mix.

Complete all sections of plant mix surfacing pavement, to be open to traffic during winter suspension, to the full plan width and thickness, excluding seal coating and open-graded friction course. Complete this work meeting the specifications before the October 15 paving cessation date.

Plant mix surfacing placed after October 15 and before April 15 is at the Contractor's risk and subject to the following conditions.

- The surface temperature to be paved must be at least 35 °F (2 °C), measured by the Project Manager.
- Apply striping within 24 hours after paving is complete on each day's work.
- Produce and place plant mix surfacing meeting all applicable specifications.

If the paving operation causes transverse joints spaced at less than one half mile (805 m), suspend work until the next April 15.

No payment is made for plant mix surfacing or asphalt on progress estimates between October 15 and April 15 for partial width or thickness.

Promptly repair damage to all partial width or thickness of plant mix surfacing used by traffic during this period for any reason including suspension of work due to adverse weather.

Provide all required interim traffic striping and signing on partially completed pavement at Contractor expense.

Failure to promptly make repairs and provide interim striping and signing is cause for the Department to perform or have the work performed and deduct the cost from monies due or that may become due the Contractor.

Payment for partial width or thickness pavement in acceptable condition will be made on the estimates following the end of the period on April 15.

- Make permanent repairs and restore partially completed pavement to the required profile, section, and condition at Contractor expense before placing any remaining lifts.
- This is not a waiver by the Department of any other contract requirement regarding the work sequence or traffic operation.

These requirements do not apply where the Project Manager requests in writing that a portion of the planned width or thickness be placed between October 15 and April 15 of the next year.

401.03.7 Existing Surface Preparation. Perform existing surface preparation meeting Section 204 requirements.

401.03.8 Prime and Tack Coat. Apply prime and tack coat meeting the applicable requirements of Sections 407 and 410 and the Contract.

Apply prime coat as directed before placing the plant mix.

Allow the prime coat to cure at least 24 hours before placing the plant mix unless otherwise approved.

Do not place plant mix on any primed surface containing free moisture, as determined by the Project Manager.

Apply tack coat on existing pavement to be overlaid and between lifts when plant mix pavement is constructed in multiple lifts.

401.03.9 Protection of Traffic and Roadway Structures.

A. Traffic Protection. Place traffic control devices meeting Section 618 requirements, and the approved traffic control plan.

At the end of each day's work, and when not in use, park all equipment at least 30 feet (9.2 m) from the outside edges of the traveled lane.

B. Protection of Roadway Structures. Protect roadway structures meeting Subsection 410.03.9 requirements.

401.03.10 Spreading and Finishing. Place and spread the mix to the widest practical width on the approved surface. Place shoulder widening material with approved equipment.

Transport and place the bituminous mix with the least possible segregation. Remove and replace segregated pavement areas behind the paver with specification material before initial rolling begins. Correct all segregated areas at Contractor expense.

Place plant mix surfacing in compacted lifts not exceeding 0.20 feet (60 mm) thick; plant mix bituminous base in compacted lifts not exceeding 0.35 feet (110 mm); and plant mix base riding course not exceeding 0.25 feet (75 mm) thick.

The Project Manager will establish horizontal alignment controls for spreading each lift.

Set a string line using the alignment control to establish one edge of the first lane of each surfacing lift. Remove all string-line used for the final lift after use.

On small or irregular areas, approaches, turnouts, around manholes, inlets, walls, and on other areas not readily accessible to a paver, plant mix material may be spread to the specified thickness by special pavers or other approved methods. Compact these areas as directed.

Place plant mix pavement at bridge ends using wire line grade control meeting the applicable requirements of Subsection 411.03.5.

Non-Interstate two lane plant mix pavements may be opened to traffic or to haul units when the mat is compacted and cooled.

Four lane routes may be opened to traffic and haul units when the mat is compacted and the surface cools to 140 °F (60 °C).

401.03.11 Constructing Joints. Continuously place each lift and provide at least a 6-inch (150 mm) offset between longitudinal joints in successive lifts. Offset transverse joints in successive lifts by at least 6 feet (1.8 m).

Correct joints not meeting the surface tolerance requirements to Subsection 401.03.14 requirements.

Uniformly coat the exposed face of all joints, excluding those formed by echelon paving, with SS-1 emulsified asphalt or other approved bitumen just before placing the abutting course.

Construct longitudinal joints in the top lift of plant mix at the centerline or lane line. If these locations are not practical, construct the joint outside the wheel paths.

Construct a vertical transverse joint the full lift depth if the mix cools below 175 °F (80 °C) before placing additional mix. Remove loose material, brush the joint face with asphalt, and compact the fresh mix against the joint face when paving is resumed.

Bevel the paving lift ends on roadways under traffic at a 20:1 ratio. When paving of the lift resumes, construct transverse joints.

When the compacted thickness exceeds 3/4-inch (19 mm), taper longitudinal joints with a 5:1 slope or flatter. Do not permit an exposed longitudinal joint length to exceed one day's paving run. Compact the joint to a minimum 95 percent of Marshall density.

Sign the new pavement end at the close of work each day meeting the Traffic Control Plan and Contract.

Construct joints at bridge ends or other rigid structures after the existing base is prepared and compacted. Apply a coat of SS-1 emulsified asphalt to portions of structures abutting the plant mix pavement.

401.03.12 Compaction, Compaction Control Testing, and Acceptance Testing.

A. Compaction. Once the plant mix is spread, struck off, and surface irregularities are corrected, compact the plant mix to at least 95 percent of the established target density. Compact and finish without displacing, over-compacting, cracking, or shoving.

Complete compaction rolling before the mat temperature falls below 175 °F (80 °C). Compaction rolling after the temperature is below 175 °F (80 °C) is cause to suspend paving operations. Compaction rolling is rolling in the vibratory mode. The Project Manager may increase the minimum 175 °F (80 °C) temperature when compaction rolling damages the new pavement.

Begin finish rolling immediately after compaction rolling and continue until roller marks are eliminated. Complete finish rolling the same day the mix is placed.

Correct any pavement displaced due to roller direction changes or other causes before final compaction.

Remove and replace any mix that is segregated, loose and broken, mixed with dirt, or is defective with fresh hot mix and compact at Contractor expense.

B. Leveling, Patching, and Thin Lifts. Subsection 401.03.12(A) does not apply to initial plant mix lifts used for leveling ruts, sags, or other existing surface defects that are less than 0.10 foot (30 mm) thick.

Perform initial rolling using oscillating-axle pneumatic-tired rollers with a minimum 20 ton (18 mt) operating weight and not less than 250 pounds (113.5 kg) per inch (25 mm) width of tire tread. Perform finish rolling meeting the requirements of Subsection 401.03.12(A). Compact the material to the density specified by the Project Manager.

C. Compaction Control Testing. The Contractor may perform density tests to control compaction or have the Department perform the tests as follows:

At Contractor request, the Project Manager will take nuclear density readings during compaction. The test locations and time may be requested by the Contractor but must not conflict with acceptance testing.

The Project Manager will provide the results, including any core density corrections, in a weight per cubic foot (weight per cubic meter) and a target density. The Contractor is to interpret these results and decide what, if any, action is required.

The tests and information furnished by the Project Manager does not relieve the Contractor's responsibility for meeting the specified density or obligation for any price reductions that may be applied under the acceptance provisions.

D. Acceptance Testing. The pavement density is determined at randomly selected locations after all rolling is complete and before the roadway is open to traffic. The density is determined using MT-212 and MT-313.

The density is divided by the Field Marshall Target density currently in effect to arrive at a percentage. The Field Marshall Target density for the mix is established by the Project Manager from the test results using MT-311.

The Project Manager will select the test locations using random selection based on the tons (metric tons) of mix placed. Areas within 1 foot (305 mm) of a free edge or where the nominal thickness is less than 0.10 foot (30 mm) are excluded from testing.

The approximate mix quantity represented by each test is 600 tons (540 mt). Additional tests may be made at the Project Manager's discretion. The quantity represented by 5 tests or approximately 3,000 tons (2700 mt) of mix will constitute a lot whenever production schedules and material continuity permit. The Project Manager will establish a lot represented by 3 to 7 consecutive random samples when there are short production runs, significant material changes, or other unusual characteristics of the work.

E. Acceptance. Plant mix surfacing is evaluated for density on a lot-by-lot basis under Subsection 105.03.2, except as noted in Subsection 401.03.12(B).

0401.03.13 Pavement Repair. Cut out the defective pavement to a minimum 1-inch (25 mm) depth. Clean the sides and bottom of the hole and apply an approved bitumen to the surfaces. Fill the hole with fresh mix, level, and compact to the specified density and surface smoothness.

401.03.14 Surface Tolerances. Finish the surface of each final lift to the specified grade and cross section. The following values specify the maximum allowable variance and divergence from the mean constructed grade:

Surface	Total Variation	Rate
New Plant Mix Bituminous Surfacing	0.02 foot (6 mm)	0.20%
Plant Mix Overlays (2 or more planned lifts)	0.03 Foot (9 mm)	0.30%
Plant Mix Overlays (less than two planned lifts)	0.03 Foot (9 mm)	No Rate

The rate is applicable only to the longitudinal direction.

New plant mix bituminous surfacing includes the plant mix seal.

The mean constructed grade for each section is the planned grade or a grade parallel to plan grade, acceptable to the Engineer.

Surfaces will be checked for compliance at joints, bridge ends, and other sections where ride characteristics or other evidence indicates surface tolerance is outside the specifications.

Surface smoothness is measured longitudinally in 100 foot (30.5 m) sections at 10 foot (3 m) intervals, and transversely at 4 foot (1.2 m) intervals. Correct out of specification plant mix bituminous surfacing by any method approved by the Engineer, including cold milling at least 0.12 foot (38 mm) deep, the full width of the defect but not less than the paver width and for 50 feet (15.2 m) each side of the defective pavement. Fill the milled area with like material and compact to the specified density.

The corrected pavement and adjoining surface must meet the smoothness specifications.

The Contractor will be notified of sections to be corrected within 3 working days after the surface was placed or the final day of paving. Perform all corrective work at Contractor expense.

Transverse joints in lifts of plant mix surfacing or other lifts to be used by traffic for 15 days or more must not vary more than 3/8-inch (10 mm) from any point on a taut 25 foot (7.6 m) string line placed parallel to centerline. Open-graded friction course and other plant mix seal courses must not vary by more than 3/16-inch (5 mm).

New surfaces will be checked for a minimum of 100 feet (30.5 m) by placing the string line in half-length increments along the roadway in traffic lanes.

Corrected areas including new joints will be checked for meeting the surface tolerances.

401.04 METHOD OF MEASUREMENT.

401.04.1 Plant Mix Pavement. Plant mix pavement is measured by the ton (metric ton) on approved scales after complete mixing of all ingredients. The pay weight includes the bituminous material and any mineral filler or hydrated lime in the mixture.

401.04.2 Bituminous Material. Bituminous material is measured by the U.S. gallon (Liter) or the ton (metric ton), as specified, under Subsection 402.04, excluding anti-stripping additive.

401.04.3 Mineral Filler. Mineral filler is measured by the ton (metric ton) under Subsection 109.01.

401.04.4 Hydrated Lime. Hydrated lime is measured by the ton (metric ton) under Subsection 109.01.

401.04.5 Anti-Stripping Additive. Anti-stripping additive is measured for payment based on invoice prices.

401.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Plant Mix Pavement	Ton (metric ton)
Bituminous Material	Gallon (liter) or Ton (metric ton)
Mineral Filler	Ton (metric ton)
Hydrated Lime	Ton (metric ton)
Anti-stripping Additive	Ton (metric ton)

Payment will not be made for any claim for rejecting any batch or load of mix containing bituminous material varying more than 0.3% from the established percentage in the job mix formula.

Mineral filler or hydrated lime used but not specified in the Contract is paid for at the invoice price per ton (metric ton), delivered to the project, plus 4 dollars per ton (metric ton) for the cost to incorporate it into the bituminous mixture.

Furnish certified copies of invoices to support the prices for mineral filler, hydrated lime, and anti-stripping additives.

Payment at the contract unit price is full compensation for all necessary resources to complete the item of work under the Contract.

SECTION 402
BITUMINOUS MATERIALS

402.01 DESCRIPTION. This work is the furnishing and applying bituminous materials, on bases and surfacing.

402.02 MATERIALS. Furnish bituminous materials meeting Section 702 and the Contract requirements.

402.03 CONSTRUCTION REQUIREMENTS. Mix and apply bituminous material meeting the applicable requirements in Sections 401, 404, 406, 407, 409, and 410.

402.03.1 Materials Source. Obtain the Engineer's approval of the bituminous source before delivering the material to the project. Do not change the source of supply once work is started, without the Engineer's written approval.

402.03.2 Sampling.

A. General. Take bitumen samples, other than products accepted under quality assurance, at the point of delivery on the project.

The Contractor or designated representative is responsible for sampling the bituminous materials on the project using MT-302.

Drain off and discard at least 1 gallon (3.8 L) of the bituminous material before drawing samples.

Draw 2 one-quart (0.9 L) samples from each shipment, witnessed by the Project Manager. Forward one sample for testing and retain the second sample for use as specified in Section 702.02.

Equip all transport vehicles with a spigot or gate valve in the unloading line, or in the tanker at the centerline of the tank, or in the pressure line from the unloading pump, or at another approved location. The spigot or gate valve diameter must be between 3/8-inch (9.5 mm) and 3/4-inch (19 mm). Locate the spigot or valve to prevent plant dust or other sample contamination.

B. Asphalt Sampling (Quality Assurance Sampling). Sample asphalt cement for plant mix surfacing and base, plant mix seal course, and open-graded friction course using a sampling device located in the line between the storage facilities and the mixing plant.

Provide a sample of the asphalt cement entering the mixing plant. One approved in-line sampling device is shown in ASTM D 140.

Place the samples in department furnished containers. Give the samples to the Project Manager immediately after sampling.

The Project Manager will randomly designate the time of sampling based on the tons (metric tons) of completed mix produced. The approximate quantity of mix represented by each sample will be 500 tons (450 mt). The Project Manager may require additional samples and testing.

Six samples will represent approximately 3000 tons (2700 mt) of mix and constitute a lot whenever production schedules or material continuity permit. The Project Manager may establish a lot consisting of the quantity represented by any number of consecutive random samples, from three to

six inclusive, when it is necessary to represent short production runs, significant material changes, or other unusual characteristics of the work.

402.03.3 Shipping. Ship the bituminous material in clean, uncontaminated, fully insulated cars or trucks, sealed by the supplier after loading.

402.03.4 Testing. Bituminous materials are accepted on the test results of samples selected and tested under Subsection 702.02 by the Department or its authorized representative.

402.03.5 Acceptance.

A. **General.** Provide the Project Manager a copy of the original bill of lading and a copy of the certificate of compliance, with each shipment. Assure the certificate is signed by the supplier's representative and attests that the bituminous material meets the Department's specifications for the type and grade of material provided and that the shipping container was inspected and found free of contamination. The certificate of compliance is the basis for tentative material acceptance and use.

B. **Asphalt Cement Penetration (Quality Assurance).** Asphalt cement for bituminous plant mix surfacing and base, open-graded friction course, and plant mix seal course is tested for penetration on a lot-by-lot basis. Acceptance is by Subsection 105.03.2. Asphalt cement with an anti-stripping additive is not evaluated under this provision.

The asphalt cement quantity in a lot, used for calculating the amount of price reduction, is based on the job mix target value of asphalt for that lot and the total tons (metric tons) of completed mix in the lot.

C. **Failures Other Than Asphalt Cement Penetration (Non-Quality Assurance).** If a shipment of bituminous material fails to meet any of the specifications, other than penetration, after the tolerances in Subsection 702.02 are applied, the material may be accepted at a 10% price reduction of the bituminous material cost.

If a shipment fails to meet any one of the specifications after twice the allowable tolerances have been applied, the price reduction will be 25 percent of the bituminous material cost.

If a shipment fails to meet any one of the specifications after triple the allowable tolerances have been applied, the Engineer may reject the material and require its removal from the work, or the Engineer may accept the material at a 50 percent price reduction of the cost of the bituminous material.

The cost of the bituminous material for calculating price reductions is the material's contract unit price.

If a shipment fails more than one of the specifications, the failure causing the largest percentage price reduction is assessed.

402.03.6 Loading and Application Temperatures. The Project Manager will designate the recommended application temperature ranges using Table 402-1.

Do not heat bituminous mix any higher than is necessary for proper hauling and placing.

Do not introduce aggregate into a mixer higher than 25 °F (14 °C) above the bituminous material temperature.

Furnish the Project Manager with data on the temperature-viscosity relationship of each asphalt to be used on the project. The data must cover the recommended temperature range and viscosities at which the asphalt may be used. The Project Manager will use this data to specify the temperature at which the material will be used.

TABLE 402-1
RECOMMENDED APPLICATION TEMPERATURES
FOR BITUMINOUS MATERIALS - DEGREES F

LIQUID ASPHALTS - RC, MC and SC

Grade	Loading Temp. Max.* °F	°C	Spraying Temp.	Mixing Temp. of Aggregates for MC & SC Liquid Asphalts			
				Min. °F	°C	Max. °F	°C
70	195	91	**As required to	90	32	155	68
250	245	118	Achieve viscosity of 50-	125	52	200	93
800	275	135	200 centistokes (25-	160	71	225	107
3000	310	154	100 Sec. Saybolt Furol)	200	93	260	127

*Line Temperatures
**See Temperature - Viscosity Charts (MT-308)

EMULSIFIED ASPHALTS

Grade	Mixing Temperature				Spraying Temperature			
	Min. °F	°C	Max. °F	°C	Min. °F	°C	Max. °F	°C
Slow and Medium Setting	50	10	130	54	50	10	130	54
Rapid Setting	—		—		120	49	160	71

ASPHALT CEMENTS

Grade	Mixing Temperature	Spraying Temperature
All Penetration Grades	Established by Project Manager	350° F Max. (177 °C)

402.03.7 Alternate Type or Grade of Bituminous Materials. The Engineer may change or substitute, in writing, the type and grade of bituminous material specified.

Payment for the changed or substituted bituminous material is the contract unit price for the type and grade of bituminous material plus or minus the difference in

Contractor's cost at the refinery between the specified and substitute type and grade.

The Engineer may change the grade of bituminous material one step at no change in price.

402.04 METHOD OF MEASUREMENT. Bituminous material is measured by the U.S. gallon (liter) or the ton (metric ton), as specified in the Contract.

If measured by the gallon (liter), the volume of bituminous material is determined at a temperature of 60 °F (15.6 °C) or corrected to this using the appropriate group table designated in the ASTM D 1250 volume correction tables. Transport bituminous materials measured by the gallon (liter) in tanks certified as to capacity. Provide a measuring rod and calibration card with each tank. Railroad tank cars must have available inage and outage tables and dome capacity charts.

When measured by the ton (metric ton), the bituminous material weight is measured on scales furnished by the supplier or on public scales close to the source. Weigh each transporting vehicle for bituminous materials, other than railroad tank cars, empty and loaded. The weight difference is used for computing the tonnage (metric tonnage). Furnish an approved scale that can weigh the transporting unit in an unbroken operation. Test and seal the scales at Contractor expense when directed.

For plant mix operations, the bituminous material may be weighed by the plant scales, if approved.

If railroad tank cars transport the bituminous materials, the railroad car weights may be used for computing the weight of bituminous material, if the loaded cars are weighed over track scales. The stenciled tare on the car used for determining the net weight is subject to verification.

Flow rate meters under Subsection 401.03.2(D)(7), will be used to measure the material. Document meter readings by invoices. The Project Manager may take tank stabs for verification purposes.

402.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Bituminous Material	Gallon (liter) or Ton (metric ton)

Payment includes all costs to furnish, deliver, heat, haul, and apply the bituminous material.

For plant mix operations, the maximum volume of bituminous material eligible for payment on a shift basis is the target bituminous content plus 0.3%.

Payment at the contract unit price is full compensation for all necessary resources to complete the item of work under the Contract

SECTION 404
OPEN-GRADED FRICTION COURSE

404.01 DESCRIPTION. This work is the mixing, spreading, and compacting of a mineral aggregate and bitumen on the prepared surface of an existing roadway pavement.

404.02 MATERIALS.

404.02.1 Aggregate. Furnish aggregate meeting the applicable requirements of Subsection 701.03.

404.02.2 Bituminous Material. Furnish bituminous material of the type and grade specified in the Contract and meeting Sections 402 and 702 requirements.

404.02.3 Anti-Stripping Additive. Furnish anti-stripping additive, if required, that meets the Contract requirements and Subsection 401.02.5(B).

404.03 CONSTRUCTION REQUIREMENTS.

404.03.1 Mix Design. Submit to the Project Manager the average of the gradation control test results and the blending proportions if more than one stockpile is to be used. Assure the aggregate gradations are within the gradation limits in Table 701-16 of Subsection 701.03.3.

Provide the Project Manager aggregate samples representing production at least 15 days before mixing operations. The Department has 15 days to issue a mix design after receipt of samples by the laboratory. Do not produce mix until a mix design is issued. The mix design establishes the recommended asphalt content, mixing and laydown temperature, and any additives required.

404.03.2 Aggregate Production. Produce and furnish material within the limits of Table 701-16 at the point of bituminizing.

Be responsible for all sampling and testing to control gradations and mechanical fracture during aggregate production. Establish a process quality control plan addressing the following:

1. Equipment Maintenance;
2. Equipment Calibration;
3. Stockpiling and materials handling;
4. Sampling and testing of component materials.

404.03.3 Acceptance Sampling and Testing.

A. Sampling.

1. **Mechanical Fracture.** Mechanical fracture tests will be by MT-217 on random samples selected by the Project Manager.

2. **Aggregate Gradation.** Gradation test samples are randomly selected by the Project Manager. Each sample will represent approximately 400 tons (360 mt). The Project Manager may require additional test samples.

   Five samples will represent approximately 2,000 tons (1800 mt) and constitutes a lot whenever production schedules and material continuity permit. The Project Manager may establish a lot of the quantity represented by 3 to 7 consecutive random samples when there are short production runs, significant material changes, or other unusual characteristics of the work.

   Gradation tests will be by MT-202.

B. Acceptance.

1. **Mechanical Fracture.** The aggregate will be evaluated for mechanical fracture requirements based on test results of samples selected by the Project Manager. Results are acceptable if the average of all tests are within specification limits and not more than 1 test out of any 5 consecutive tests is outside these limits.

   Do not begin plant mixing operations until the stockpiled aggregates meet these requirements.

2. **Gradation.** OGFC is accepted on a lot by lot basis under Subsection 105.03.2.

404.03.4 Equipment. Use a mixing plant, paver, and other equipment, excluding rollers, that meet the applicable requirements of Section 401 and Section 210.

Use non-vibrating, flat, smooth, steel wheeled, self-propelled rollers weighing between 175 to 225 pounds per linear inch (79.5 to 102 kg per 25 mm) of rolling width per drum. Use lighter rollers if aggregate breakage occurs.

404.03.5 Traffic Control. Establish traffic control meeting the approved traffic control plan and Section 618.

404.03.6 Paving Dates and Weather Limitations. Do not place open graded friction coarse from September 15 to May 15 of the following year.

Place open graded friction coarse only during daylight hours; when the surface is dry; when the surface temperature is a minimum 60 °F (16 °C); and when the ambient temperature is above 60 °F (16 °C).

The Project Manager may suspend paving due to weather considered detrimental to the work.

404.03.7 Preparation of Existing Surface. Complete all required patching, leveling, and crack filling before placing the OGFC.

Clean loose and defective material from holes and depressions to sound pavement. Coat the surface with an approved bituminous material, and fill with a hot-mix asphalt patching material. Compact patched areas to produce a tight, smooth surface matching the adjacent pavement area.

Apply a thin coating of bituminous material to the contact surfaces of curbing, gutters, manholes, and other structure surfaces before placing the OGFC.

Remove all dust, dirt, and foreign matter on the roadway before applying the first application of bituminous material.

404.03.8 Tack Coat. Apply tack coat at 0.02 to 0.05 gallons per square yard (0.1 to 0.23 liters per square meter) of SS-1 emulsified asphalt or as directed.

To provide complete coverage, the emulsion may be diluted meeting the requirements of Subsection 407.03.3. Apply diluted emulsion at a rate proportionate to the dilution rate.

Assure the emulsified asphalt is fully cured before placing the OGFC.

404.03.9 Mixing. Dry and heat the mineral aggregate to a maximum temperature of 275 °F (135 °C). Collect and dispose of dust from heating the aggregate or return it to the hot elevator.

Thoroughly mix to uniformly coat the mineral aggregate with asphalt cement. Heat to the mixing temperature specified in the mix design formula.

Use burner fuel meeting Subsection 401.03.2(A)(13) requirements.

404.03.10 Dumping. The OGFC mixture may be dumped directly into the paver or windrowed on the pavement ahead of the paver.

404.03.11 Spreading. Spread the OGFC with a paver or pavers meeting Subsection 401.03.2(F)(1) requirements.

Produce longitudinal and transverse joints meeting Subsection 401.03.11 requirements.

404.03.12 Rolling. Immediately after placing the OGFC, roll the entire surface once.

Begin rolling on the low side of the paving lane and work towards centerline longitudinally and parallel. Overlap the preceding strip by at least 6-inches (150 mm).

Operate rollers to prevent shoving, distortion, break rocks, or stripping under the roller. Continue rolling until the OGFC is consolidated and bonded to the underlying surface course.

404.03.13 Finishing. Finish the surface to the plan dimensions.

Correct all defective areas immediately at Contractor expense. Remove and replace defective areas with new material and compact meeting the adjacent surface.

Do not permit traffic on the OGFC without the Project Manager's approval.

404.03.14 Surface Tolerances. Finish the surface meeting Subsection 401.03.14 requirements.

404.04 METHOD OF MEASUREMENT.

404.04.1 Open-Graded Friction Course. OGFC mix is measured by the ton (metric ton) under Subsection 401.04.1.

404.04.2 Bituminous Material. Bituminous material is measured by the U.S. gallon (L) or the ton (metric ton) under Subsection 401.04.2.

404.04.3 Mineral Filler and Anti-Stripping Additive. Mineral filler and anti-stripping additive is measured under Subsections 401.04.3 and 401.04.5 respectively.

404.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is measured under the following:

Pay Item	Pay Unit
Open Graded Friction Course	Ton (metric ton)
Bituminous Material	Gallon (liter) or Ton (metric ton)
Mineral Filler	Ton (metric ton)
Anti-Stripping Additive	Ton (metric ton)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract. Cleaning the roadway surface before placing the OGFC mixture is included in payment for other items of this Section.

SECTION 406
ROAD MIX BITUMINOUS PAVEMENT

406.01 DESCRIPTION. This work is the construction of one or more courses of a mixture of aggregate and bituminous material, mixed and processed on the roadway.

406.02 MATERIALS.

406.02.1 Bituminous Material. Furnish the type and grade of bituminous material specified in the Contract meeting the requirements of Sections 402 and 702.

406.02.2 Aggregate. Furnish the aggregate specified in the Contract meeting the applicable Section 701 requirements.

406.03 CONSTRUCTION REQUIREMENTS.

406.03.1 Prosecution of Work. Furnish the resources to complete at least one half mile (0.80 km) of continuous road mix bituminous pavement each day on projects 5 miles (8 km) or more in length.

On projects less than 5 miles (8 km) in length, complete the work within 10 working days.

Do not open up more than 2 miles (3.2 km) of work to any one phase of construction. Do not perform bituminous construction on more than 3 contiguous miles (4.8 km) of roadway.

406.03.2 Equipment.

A. Bituminous Distributor. Maintain on the project at least one bituminous distributor meeting Subsection 410.03.1(A) requirements.

B. Motor Graders. Use motor graders meeting Subsection 210.03.2 requirements.

C. Road Plants and Machines. Use equipment capable of producing the specified work.

Do not damage the existing surface. Remove any equipment that damages the roadway or does not produce the specified work.

D. Stationary Plants. A stationary plant may be used for mixing the new aggregate and bituminous material, if approved. Mixing and aeration of the material, if not completed in the plant, must be completed on the roadway meeting these specifications.

The Project Manager may permit mixing, spreading, and compacting the materials under Section 401.

E. Rollers. Furnish rollers meeting Subsection 210.03.4 requirements.

406.03.3 Limitations and Conditions.

A. Weather, Season, and Time. Perform road mix bituminous paving when the roadway surface is dry, the temperature is above 50 °F (10 °C) and during daylight hours.

B. Stockpiling. Windrow stockpile the aggregate on the roadway only for mixing operations that can be completed without interruption.

The Contractor may produce and stockpile the aggregate off the roadway at its own expense. Stockpile aggregate meeting Subsection 303.03 requirements.

C. Moisture Content. Do not allow the aggregate moisture content to exceed 3% by weight before applying the bituminous material.

When emulsified asphalt is specified, the maximum moisture content of the aggregate is specified in the Contract or directed by the Engineer.

Cease work during periods of rain and immediately windrow the material. Maintain drainage away from the windrows.

Dry the treated material and the base before resuming work. Mixing is permitted to aid drying. Place the bituminized mixture on the roadbed, once approved by the Project Manager. Do not place the mixture if the moisture content in the upper 6-inches (150 mm) of the base exceeds 3½% .

406.03.4 Traffic Control and Protection of Highway Structures. Place traffic control meeting the Contract requirements and the approved traffic control plan. Protect highway structures meeting the requirements of Subsection 410.03.9.

Park all equipment at least 30 feet (9.2 m) from the edge of the traveled way or place it a minimum 10 feet (3 m) behind guardrail when work is suspended and traffic has use of the roadway.

Leave all material in a uniform windrow without interfering with traffic, signed and delineated as specified or directed. Leave the roadway in a safe condition for the traveling public.

406.03.5 Prime or Tack Coat. Apply the prime or tack coat under Section 407.

406.03.6 Aggregate. Where aggregate is recycled from the existing roadway, scarify the surface to produce the material quantity required for the compacted thickness of bituminous surfacing shown in the plans. Do not disturb the base surface below the depth required to produce the necessary quantity of material. Break all clods and windrow the loose material. Shape and compact the base surface to the typical section.

Uniformly mix recycled and new material before applying the bituminous material.

When only new aggregate is to be used, shape and compact the existing roadway surface to the specified sections. Apply prime coat as specified before placing the new aggregate. Uniformly windrow the new aggregate on one side of the roadway. Make the windrow uniform in size throughout its entire length.

406.03.7 Application of Bituminous Material. Apply bituminous material at the rates, temperature, and manner specified. Assure all aggregate is uniformly coated with bituminous material.

When applying bituminous material with distributors or mixing machines equipped with applicators, spread the windrowed aggregate in successive layers at least 8 feet (2.4 m) wide. Uniformly apply the bituminous material to the full width of each layer. Make at least 3 layers of aggregate and bituminous material.

406.03.8 Processing. Blade all surfacing material into a windrow after the last application of bituminous material and partial mixing. Move the windrow from side to side of the roadway a minimum of 8 times working the aggregate until it is uniformly coated with bituminous material and is aerated for spreading and compacting.

A move is moving the entire mass from one edge of the roadway section to the other. If necessary, make additional moves to produce the desired mix uniformity. Prevent segregation of material or loss of mineral filler from the mixture.

Once mixing is completed, the Project Manager will inspect the mixture for acceptance. If excessive bituminous material was applied, add additional aggregate to the mixture and thoroughly blend by blade mixing. If more bituminous material is required, spread the mixed material needing more bitumen on one side of the roadway, add the required additional bituminous material and resume mixing until the mix is uniform.

Remove oversize material in the mixture during mixing.

406.03.9 Spreading and Compacting. Spread the mixed material to the specified thickness using a pneumatic-tired motor grader.

Compact the material with a self-propelled pneumatic-tired roller that provides at least 60 psi (414 kPa) pressure on the mat.

Continue rolling until the mat is uniformly and thoroughly compacted leaving no roller marks. Begin rolling on the low side of the paving lane and roll lengthwise and parallel to the high side, each pass overlapping the preceding pass by at least 6-inches (150 mm).

Final roll using a metal-wheeled roller operated at speeds between 3 (5 kph) and 8 (13 kph) miles per hour. Correct roller speed if the roller displaces the material.

Do not use kerosene or diesel fuel to prevent pickup on the finishing roller. Correct all defects before opening the road to traffic.

The finished surface must be free of ruts, depressions or other surface defects exceeding 3/8-inch (10 mm), as measured with a 10 foot (3 m) straightedge paralleling the roadway center. Make corrections by scarifying and relaying the mixture at Contractor expense.

406.03.10 Seal Coat. Apply seal coat when specified under Section 409.

406.04 METHOD OF MEASUREMENT.

406.04.1 Bituminous Material. Bituminous material is measured by the gallon (liter) or ton (metric ton) under Subsection 402.04.

406.04.2 Aggregate. New or additional aggregate for the bituminous surfacing course and the shoulders is measured by the cubic yard (cubic meter) or ton (metric ton) under Subsection 301.04.1.

406.04.3 Processing. Processing of all bituminous surfacing materials is measured by the mile (km) along the centerline of the roadway or by the square yard (square meter).

406.04.4 Rolling. Rolling is incidental to and included in payment for other items of the work.

406.04.5 VACANT.

406.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Bituminous Material	Gallon (liter) or Ton (metric ton)
Aggregate	Cubic Yard (cubic meter) or Ton (metric ton)
Processing	Mile (kilometer) or Square Yard (square meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

When emulsified asphalt is specified, the cost of additional water required during mixing is included in the unit price for emulsified asphalt.

The grade of bituminous material may be changed one step by the Engineer with no adjustment in price.

When stationary plants are used for mixing, the weight of bituminous materials and mixing water are deducted from the total mix weight.

SECTION 407
BITUMINOUS PRIME AND TACK COAT

407.01 DESCRIPTION. This work is the furnishing and applying a bituminous material, and a blotter material if required, to an existing surface.

Prime coat is applying a bituminous material to a prepared aggregate or soil-surface roadway before placing bituminous surfacing.

Tack coat is applying a bituminous material to a constructed bituminous or concrete surface before placing a bituminous surfacing.

407.02 MATERIALS

407.02.1 Bituminous Material. Furnish bituminous material meeting Section 702 requirements for the type and grade specified.

The Project Manager may change or substitute the type and grade of bituminous material to be used under Subsection 402.03.7.

A one step change in grade will not change the unit price.

The Contractor may substitute CSS-1 emulsified asphalt for SS-1 emulsified asphalt for tack coat.

407.02.2 Blotter Material. Blotter material is material with 100% passing the ½-inch (12.5 mm) screen and having a PI of 6 or less.

407.03 CONSTRUCTION REQUIREMENTS.

407.03.1 Weather Limitations. Apply prime and tack coat to a dry surface during daylight hours, and when the ambient temperature is 50 °F (10 °C) or higher.

Apply the prime or tack coat after the Project Manager has approved the surface to receive the bituminous material.

Apply tack coat subject to the surface conditions and weather limitations in Subsection 401.03.6.

407.03.2 Equipment. Use equipment meeting Subsection 410.03.1 requirements.

407.03.3 Application of Bituminous Materials. Apply bituminous material as specified in Subsection 410.03.4, except as modified or supplemented by this subsection.

The 3% moisture requirement in Subsection 410.03.2 is not applicable.

The Project Manager will establish the bituminous material application rate.

Apply water as directed to the aggregate base surface before the surface is primed.

Treat only one-half of the roadway width in one application.

Do not exceed the specified quantity of bituminous material at spread junctions. Correct excess or deficient coated areas to the specified application rate.

Apply emulsified asphalt for tack coat as specified by the Project Manager up to a maximum rate of 0.1 gallon per square yard (0.45 L per m^2). Maintain from 1 to

3 parts of water to 1 part of emulsified asphalt. The Project Manager will determine the exact proportions.

407.03.4 Application of Blotter Material. Spread, and compact if required, blotter material over primed surfaces as directed.

Sweep or blow excess blotter material onto the shoulders and in-slopes before placing subsequent bituminous surfacing courses. Remove and dispose of all excess material on adjoining curbs and gutters.

407.03.5 Maintenance of Surface. Maintain the prime or tack coated surface until covering with subsequent surfacing.

Repair all defects, deterioration or disintegration of the underlying surfacing course or courses as directed.

407.03.6 Traffic Control and Protection of Highway Structures. Furnish traffic control meeting the approved traffic control plan and Section 618.

Furnish highway structure protection as specified in Subsection 410.03.9.

407.04 METHOD OF MEASUREMENT.

407.04.1 Bituminous Material. Bituminous material is measured by the gallon (Liter) or the ton (metric ton), as specified, under Subsection 402.04.

407.04.2 Blotter Material. Blotter material is measured by the ton (metric ton) or cubic yard (cubic meter).

407.04.3 Surface Repair. The surface repairs in Subsection 407.03.5 are not measured for payment except as follows:

The Project Manager may direct priming the surface before a winter shutdown. All traffic related damage areas during the shutdown period that are repaired are measured for payment at the appropriate contract unit prices, including additional materials.

407.04.4 Miscellaneous. Water for diluting emulsified asphalt used in the work is not measured for payment.

407.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Bituminous Material	Gallon (liter) or Ton (metric ton)
Blotter Material	Ton (metric ton) or Cubic Yard (cubic meter)

Payment at the contract unit price is full compensation for all necessary resources to complete the item of work under the Contract.

The bituminous material quantities in the Contract are estimated and may be increased or decreased with no adjustment of the contract unit prices.

The blotter material quantity in the Contract is estimated and may be increased or decreased with no adjustment in the contract unit price.

SECTION 409
SEAL COAT

409.01 DESCRIPTION. Seal coat is the application of a bituminous material, covered with aggregate on an existing roadway surface.

409.02 MATERIALS.

409.02.1 Bituminous Material. Furnish bituminous material, either an emulsified or liquid asphalt as specified, meeting Section 702 requirements.

409.02.2 Cover Aggregate. Furnish cover aggregate meeting Subsection 701.02.8 and Table 701-12 requirements.

The responsibility for furnishing the aggregate source is specified in the Contract.

409.03 CONSTRUCTION REQUIREMENTS.

409.03.1 Sampling, Testing, and Acceptance. Sampling, testing, and acceptance of cover aggregate is under Subsection 301.03.1 and the following:

Furnish at least 2 aggregate sampling pans, each a minimum of 2 feet x 2 feet X 2-inches (610 mm X 610 mm X 50 mm). Leg mount or support the pans to prevent disturbing the fresh asphalt when sampling.

Take samples while spreading chips, at locations randomly selected by the Project Manager. Place 2 sample pans on the roadway immediately ahead of the spreader between the spreader wheel paths. Stagger the pans longitudinally and transversely 3 to 6 feet (915 mm X 1,830 mm) apart.

Once the spreader passes, retrieve the sample pans and turn them over to the Project Manager.

Replace or correct all asphalt removed or disturbed by the sampling and place cover aggregate over the sampling areas at the specified rate. Maintain the pans in good, clean condition.

409.03.2 Aggregate and Bituminous Material Application Rates. Request the Project Manager to sample the stockpiles representing the total cover aggregate production at least 15 days before seal coat work is to begin.

Recommended application rates for the cover and bituminous materials are established from these samples.

Do not begin seal coat work until the recommended application rates are established.

409.03.3 Equipment.

- **A. Distributors.** Use distributors meeting Subsection 410.03.1(A) requirements. Use spray bars capable of varying the application rates across the bar width up to 10 percent.
- **B. Power Brooms.** Use rotary power brooms that are in good operable condition.
- **C. Rollers.** Furnish pneumatic-tired rollers under Subsection 210.03.4 (D).

D. **Aggregate Spreaders.** Furnish aggregate spreaders meeting Subsection 410.03.1© requirements.

409.03.4 Seasonal and Weather Limitations. Begin seal coat work only with the Project Manager's approval. The following conditions govern seal coat work unless otherwise directed:

1. Perform seal coat operations between May 1 and August 20.
2. Do not perform seal coat work during the 48-hour period immediately preceding a holiday or a holiday weekend except for pilot car operation as specified in Subsection 409.03.13.
3. Do not perform seal coat work if the local radio weather forecast includes a predicted temperature lower than 45 °F (7 °C) within 12 hours after the intended close of work for the day. The Project Manager will determine which local radio forecast applies to the project.
4. Do not perform seal coat work if the local radio weather forecast includes a probability of precipitation greater than 45% within the intended schedule of operations for the day. Regardless of the weather forecast, seal coat work may be suspended if impending adverse weather conditions occur in the vicinity of the work.
5. Perform seal coat work only when both the ambient and mat temperatures exceed 65 °F (18 °C). When high-float emulsified asphalt's are used, the minimum temperature is 60 °F (16 °C).
6. Do not apply bituminous material to damp or wet roadway surfaces.
7. Immediately stop seal coat work if the wind velocity affects the distributor spray pattern or if current weather conditions prevent producing the specified results.
8. Stop seal coat work at least ½ hour before sunset.

409.03.5 Aggregate Production and Stockpiling. Produce and stockpile aggregate under Section 301.

409.03.6 Protection of Traffic and Highway Structures. Furnish traffic control meeting the approved traffic control plan and Section 618.

Furnish highway structure protection meeting Subsection 410.03.9(B) requirements.

409.03.7 Sweeping. Clean the roadway surface of all dust, dirt, and foreign material immediately before applying bituminous material.

409.03.8 Application of Bituminous Materials. Apply the bituminous material at the required temperature and rate using a pressure distributor.

Apply the liquid asphalt within the temperature range shown in Table II of MT-308 for the specified grade and manufacturer of the bituminous material.

The Project Manager may vary the application rate during the work.

Remove and correct any distributor causing drill marks or other defects.

When directed, calibrate the application rate on 1 or more 2,000 linear feet (610 m) shots.

Do not apply the bituminous material until cover aggregate for the entire application is immediately available.

Notify the Project Manager when the aggregate is available for sampling under Subsection 409.03.1.

Apply the bituminous material and cover aggregate at transverse and longitudinal joints so it is smooth and blends with the completed adjacent surface.

Longitudinal joints may be from 6 to 10-inches (155 to 255 mm) wide. Keep meet lines to a minimum, and locate them outside of the wheel paths. Prevent lapping at transverse joints. Before continuing the application, spread protective sheets back from the joint on the cover aggregate to prevent overlap.

The Project Manager may approve full roadway width bituminous and cover aggregate application in a single, continuous operation, sequenced to create the least inconvenience to traffic.

Do not permit traffic and aggregate haul trucks to cross over or drive on any uncovered bituminous material.

409.03.9 Application of Cover Aggregate. Uniformly apply the cover aggregate over the bituminous material at the directed rate. The spreader application rate must be controlled independently of its motive power. Remove aggregate spreaders from the work that do not uniformly distribute the aggregate in longitudinal lines.

The Contract cover aggregate quantities are an estimate only, and actual coverage rates may vary and are determined by the Project Manager.

Cover all transverse joints with aggregate and broom the aggregate back before applying the adjacent bituminous material. When longitudinal joints are covered to permit vehicle cross over, broom back the cover aggregate to expose the full width of the joint before applying the abutting bituminous material.

Use mechanical or hand brooming methods to make minor corrections to the cover aggregate distribution. Avoid displacing or loosening of the cover aggregate.

409.03.10 High-Float Emulsified Asphalts and Liquid Asphalts. Wet aggregate in the stockpile or in the trucks as required. Water carefully to minimize fines migration and contamination at the stockpile bases.

Permit high-float emulsions to develop a slight skin surface before applying cover material. The skin has developed when the surface of the high-float emulsion is black, with a brown color beneath the surface. Depending on weather conditions, the skin surface should form in 5 to 15 minutes after application.

409.03.11 Emulsified Asphalts. Assure the cover aggregate is wet when applied to the roadway. Water the aggregate as required. Water carefully to minimize fines migration and contamination at the stockpile bases.

For cationic emulsions, allow no more than one minute to elapse between applying the bituminous material and the aggregate covering. If an emulsified asphalt is not covered before it begins to break, the Project Manager will direct corrective steps, which may include applying additional materials, at Contractor expense.

409.03.12 Rolling. Begin rolling immediately behind the spreader. Provide the number of rollers needed to cover the full width of the aggregate spread in one pass.

Make at least 4 complete passes with each roller. Do not allow the roller speed to exceed 7 mph (11 kph) on the initial coverage. Additional rolling may be required.

409.03.13 Opening to Traffic. Open the roadway to traffic within one week after the seal coat work is completed. Use pilot cars to control the traffic's speed to not exceed 20 mph (32 kph) for the first 48 hours after opening to traffic.

Equip and operate pilot cars under Section 618.

On new constructed surfaces assure vehicles and equipment do not exceed 20 mph (32 kph) for the first 48 hours after opening. Promptly remove from the project personnel not observing this speed limit.

Broom on the day following the seal and cover application and before discontinuing the use of the pilot car. Broom in the early morning to minimize dust and to reduce loosening or displacing of embedded aggregate. Provide additional rolling if required.

If the seal coat fails to cure properly, or if inclement weather interrupts the 48 hour curing period, continue traffic control as directed.

Correct surface irregularities affecting the ride quality at Contractor expense. Cover areas showing excess bituminous material with additional aggregate or blotter material at Contractor expense.

409.04 METHOD OF MEASUREMENT.

409.04.1 Bituminous Material. Bituminous material is measured by the gallon (Liter) or by the ton (metric ton) under Subsection 402.04.

409.04.2 Cover Aggregate. Cover material is measured by the ton (metric ton) or by the cubic yard (cubic meter) under Subsection 301.04.1.

409.04.3 Traffic Control. Traffic control, including pilot car operation, is measured under Subsection 618.04.

409.04.4 Rolling. Rolling up to and including four complete passes is not measured for payment. Additional rolling directed by the Project Manager, beyond the specified four passes, is measured by the hour.

409.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Bituminous Material	Gallon (liter) or Ton (metric ton)
Cover Aggregate	Cubic Yard (cubic meter) or Ton (metric ton)
Traffic Control	See Subsection 618.05
Additional Rolling	Force Account

Payment at the contract unit price is full compensation for all necessary resources to complete the item of work under the Contract.

409.05.1 Excess Crushed Cover Aggregate. Sale of excess crushed cover aggregate is the Contractor's option. The Contractor cannot sell material from Department-owned or Department-optioned sources without a written agreement establishing and providing royalty refunds to the Department.

The Department may purchase the acceptable unused crushed cover aggregate remaining in the stockpile, if the quantity exceeds 100 tons (90 mt). The conditions of purchase are described in Subsection 109.07.

Haul from the stockpile site to the site selected by the Engineer will be by the most practical haul route determined by the Engineer. Payment for haul is 15 cents per ton mile (0.907 mt per 1.6 km)) only for distances exceeding 2,000 feet (610 m).

SECTION 410
BITUMINOUS SURFACE TREATMENT

410.01 DESCRIPTION. This work is applying one or more coats of bituminous material on a prepared aggregate roadway surface, covering each application with aggregate surfacing material.

410.02 MATERIALS.

410.02.1 Bituminous Material. Furnish the specified bituminous material under Section 702.

410.02.2 Aggregate. Furnish the specified aggregate under Section 701.

410.03 CONSTRUCTION REQUIREMENTS.

410.03.1 Equipment. Maintain the following equipment on the project throughout the work.

A. Distributor. One pressure distributor for bituminous material with a minimum 1,000-gallon (3785 L) capacity insulated tank, internally heated.

Equip the distributor with a full-circulating spray bar:

1. At least 9 feet (2.8 m) long;
2. Capable of 1 foot (305 mm) incremental length adjustments up to 16 feet (4.9 m);
3. Having vertical nozzle adjustment that conforms to the roadway crown;
4. Capable of lateral shifting of the entire spray bar while operating;
5. With vertical height adjustment capable of maintaining a preset height above the road surface.

Use spray bars and flat-slotted nozzles designed to not clog during intermittent operation and provide positive cutoff of the bituminous material. Use positive-acting flow control valves to produce a uniform, unbroken spread of bituminous material.

Remove or repair distributors not uniformly distributing the bituminous material.

Assure the distributor has devices and charts to provide for accurate, rapid determination and quantity control of the bituminous material application.

Equip the distributor with a pressure pump, pressure gauge, thermometer well, thermometer, and a calibrated fluid content gauge.

Use pneumatic-tired distributors meeting legal load requirements.

B. Rollers. Furnish pneumatic tired rollers under Subsection 210.03.4(D).

C. Aggregate Spreader. Provide one self-propelled aggregate spreader:

1. Equipped with at least 4 pneumatic tired wheels on 2 axles;
2. Capable of uniformly spreading the material over the full width of the bituminous material;
3. The spreader application rate being independent of motive power.

D. **Cleaning Equipment.** Use power brooms, blowers, or hand brooms.
E. **Watering Stockpiles.** Provide equipment for wetting the cover aggregate stockpiles, when required.
F. **Watering Equipment.** Furnish water distributing equipment meeting the applicable requirements of Subsection 210.03.5.
G. **Scales.** Furnish scales under Subsection 301.03.2(C).

410.03.2 Existing Surface Preparation. Unless surface preparation is included in the contract surfacing item, perform the work under Section 204, as modified or supplemented below.

When required, apply a light, uniform water application to the roadway surface just before applying the bituminous material. Do not exceed 3% moisture by weight in the top 2-inches (50 mm) of the aggregate course.

When required, apply a prime coat of bituminous material at the rate directed before the initial application of bituminous surface treatment. Apply the prime coat under Section 407.

410.03.3 Sweeping. Clean the roadway surface of all dust, dirt, and foreign material before applying the bituminous material.

410.03.4 Application of Bituminous Material. Apply the bituminous material with a maximum allowable variation of 0.02 gallon per square yard (0.4 L per m^2) from the specified application rate.

Apply bituminous material only with the Project Manager's approval. Apply the material when the surface temperature is at or above 60 °F (16 °C).

Do not work when rain, wind, or temperatures would prevent obtaining the specified results.

Uniformly apply the bituminous material at the temperature and rate specified. Provide uniform surface cover and true lines.

Assure high viscosity bituminous materials are covered with aggregate within 5 minutes.

Apply bituminous material to produce smooth and consistent transverse and longitudinal joints in successive applications with the adjacent completed surfaces.

Longitudinal joints may be from 6 to 10-inches (150 to 255 mm) wide but not overlap at the application ends. Prevent lapping at transverse joints by inserting a drip pan under the nozzles if necessary. Before continuing the application, spread protective sheets over the treated surface on the cover aggregate to provide bituminous coverage at the joint.

Apply the material to keep meet lines to a minimum.

The Project Manager may approve full width application of bituminous material and cover aggregate in a single, continuous operation.

Re-apply bituminous material at joints where the uncovered bituminous material has set and will not bond the aggregate at Contractor expense.

410.03.5 Application of Cover Aggregate. When directed, water the stockpiled cover aggregate before spreading it on the bituminous material.

Cover the first bituminous material application within 60 minutes. Uniformly cover all bituminous material with cover aggregate at the specified rate. When directed, use brooms to uniformly distribute the cover aggregate. Avoid displacement or loosening of the cover aggregate.

Do not permit haul trucks and traffic to drive on any uncovered bituminous material. Furnish traffic control for fresh spread cover aggregate areas as specified in the traffic control plan.

Before applying the adjacent bituminous material, broom all joints the full width to remove loose aggregate.

410.03.6 Rolling. Roll the cover aggregate immediately after spreading within 30 minutes of spreading.

Use self-propelled pneumatic-tired rollers with a ground contact pressure of between 50 psi (345 kPa) and 95 psi (656 kPa). Provide 2 rollers for each aggregate spreader used.

Roll parallel to the centerline; starting on the low side of the lane and working towards the crown or high side. Overlap roller passes at least 6-inches (155 mm).

Continue rolling until a smooth, compacted surface is produced.

Avoid displacing or loosening the cover material while rolling.

410.03.7 Curing and Cleaning. When the rolling is completed on each surface course and the surface is accepted, it may be opened to traffic.

Allow the surface to cure for at least 5 days.

Repair all surface defects in the treated surface immediately with the specified bituminous material or use a pre-mix bituminous aggregate at Contractor expense.

Cover areas of excess bituminous material with aggregate and roll at Contractor expense.

When the Project Manager determines the first course of bituminous material and cover aggregate has cured and set, all repairs have been accepted, all excess cover aggregate is removed, clean the surface of dirt, dust, and foreign materials.

Begin construction of the succeeding course on the cleaned surface.

410.03.8 Completion. When the final course is complete, open the surface to traffic for 3 days, using the specified traffic control. During this time, broom and roll the surface as required.

Repair all surface defects under Subsection 410.03.7.

Cover all areas exhibiting excess bituminous material with aggregate and roll it.

410.03.9 Protection of Traffic and Highway Structures.

A. **Traffic Control.** Furnish traffic control meeting the contract requirements and Section 618.

B. **Structure Protection.** Cover exposed bridge elements, culverts, curbs, gutters, guard fences, road signs, and other roadside structures to protect them from splash or spray when applying bituminous material.

Clean these same items of all bituminous material, dirt, or other material caused by the Contractor's operations.

Repair all Contractor caused damage to the highway or structures at Contractor expense.

410.04 METHOD OF MEASUREMENT.

410.04.1 Bituminous Material. Bituminous material is measured by the gallon (Liter) or the ton (metric ton) under Subsection 402.04.

410.04.2 Cover Aggregate. Cover aggregate is measured by the ton (metric ton) or the cubic yard (cubic meter) measured in the vehicle at the point of delivery on the roadway, as specified in the Contract and under Subsection 301.04.1.

410.04.3 Traffic Control. Traffic control is measured under Subsection 618.04.

410.04.4 Existing Surface Preparation. Where base construction is a part of the Contract with bituminous surface treatment, the items of work for existing surface preparation are incidental to and included in payment for the base construction.

Where bituminous surface treatment is applied to an existing aggregate surface, the work for existing surface preparation is measured for payment under Subsection 204.04.

410.04.5 Rolling and Watering. Rolling and watering are incidental to other items of the Contract and not measured for payment.

410.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Bituminous Material	Gallon (liter) or Ton (metric ton)
Cover Aggregate	Cubic Yard (cubic meter) or Ton (metric ton)
Traffic Control	See Subsection 618.05

Surface sweeping or cleaning, watering of aggregate stockpiles and the roadway surface, repairing damaged surfaces or surfaces with excess bituminous material, and protection and repair of structures specified in Subsection 410.03.9(B) are incidental to and included in payment for other items of the Contract.

410.05.1 Existing Surface Preparation. Existing surface preparation, when specified, is paid under Subsection 204.05.

When not specified in the Contract, the existing surface preparation work is incidental to and included in the payment for the base construction.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 411
COLD MILLING

411.01 DESCRIPTION. This work is the removal of existing bituminous pavement at the locations specified in the Contract or designated by the Engineer.

411.02 VACANT.

411.03 CONSTRUCTION REQUIREMENTS.

411.03.1 Equipment. Use a power-operated cold milling machine equipped to control cross slope and to establish profile grade from the existing pavement or an external reference.

Use cold milling machines having a minimum single pass cutting width of 12 feet (3.7 m) where one or more full lanes are designated for removal except for the following conditions:

1. Cattle Guards and bridge ends;
2. Two-Lane Two-Way roads 40 feet (12.2 m) in width or less where the total removal is less than 25,000 square yards (20,900 m^2).

Equip the milling machine to capture milling related dust.

411.03.2 General. Do not start cold milling until the plant mix material is available.

Remove all thin delaminated or loose layers of existing pavement left after cold milling.

Replace the milled pavement at bridge ends and cattle guards with new bituminous surfacing the same day leaving no transverse joints in the milled areas.

If new surfacing cannot be place on the milled area the same day of the milling, taper the edges at structures and cattle guards at 50:1 with hot mix. Remove and dispose of the tapers immediately before placing the planned overlay on the milled area.

Replace all other areas designated for milling with new bituminous surfacing the same day that the milling is performed.

Replacing existing pavement is a separate operation from any succeeding overlay or lift.

411.03.3 Milling.

A. **Bridge and Cattle Guard Approaches and Bridge Decks.** Mill the existing bituminous surfacing from bridge decks, bridge approaches, and cattle guards at the locations specified in the Contract.

Mill to the plan depth from the bridge ends out to a maximum 50 feet (15.3 m) from the bridge end. Taper the mill depth from that point to the level of the existing pavement surface from a minimum 10 feet (3 m) to a maximum 150 feet (45.8 m), as directed.

At cattle guards, the full depth milling distance will vary from 0 to 40 feet (12.2 m), and the taper milling distance will vary from 10 to 80 feet (3 to 24.4 m), as directed.

Bridge deck mill depth is shown in the Contract.

B. Milling at Other Designated Areas. Mill the existing pavement at the locations, widths and depths specified. Depths specified are minimums. The depth is measured below the existing pavement plane projected from points on un-distorted pavement near the centerline and the edge of the driving lane.

411.03.4 Salvage of Pavement Millings. Salvage, haul, and stockpile the milled pavement to the specified site.

Milled pavement is the Contractor's property when specified and must be removed from the project.

411.03.5 Replacing Removed Pavement. Pave all milled areas in the Contract with the specified bituminous mixture, placed to the specified depth.

Grades will be provided at 50 foot (15.3 m) intervals for placing the new pavement for 250 feet (76.3 m) from each bridge end and 100 feet (30.5 m) from cattle guards. Set a wire line for grade control with intermediate supports to prevent wire deflection exceeding 0.015 feet (5 mm). Stop paving if the deflection exceeds 0.015 feet (5 mm) and make appropriate corrections.

Apply a tack coat on all milled areas before paving.

411.03.6 Traffic Control. Furnish traffic control under Section 618.

411.04 METHOD OF MEASUREMENT. Cold milling is measured by the square yard (square meter) of pavement removed to the specified depth. If directed in writing to mill to a depth 20% or greater than specified, the measured area is increased by the ratio of the ordered depth to the specified minimum depth. No adjustment in measurement is made for increases in mill depth up to 120% of the specified depth.

411.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Cold Milling	Square Yard (square meter)

Payment at the contract unit price is full compensation for all necessary resources to complete the item of work under the Contract.

SECTION 501
PORTLAND CEMENT
CONCRETE PAVEMENT

501.01 DESCRIPTION. This work is the construction of portland cement concrete pavement on a prepared sub-grade or base course.

501.02 MATERIALS.

501.02.1 Concrete. Furnish concrete meeting Section 551 requirements for class "AP" or "DP" concrete.

- **A. Cement.** Furnish Type II portland cement meeting AASHTO M 85 requirements and the applicable requirements of Subsection 551.02.1.
- **B. Air-Entraining Admixtures.** Furnish Air-entraining admixtures meeting Subsection 551.02.2 requirements.
- **C. Fine Aggregates.** Furnish fine aggregate meeting Subsection 701.01.1 requirements.
- **D. Coarse Aggregates.** Furnish coarse aggregate meeting Subsection 701.01.2 requirements.
- **E. Water.** Furnish water for concrete meeting Subsection 713.01 requirements.

501.02.2 Reinforcing Steel. Steel-wire fabric and steel bar mat sizes and dimensions are specified in the Contract.

Furnish steel-wire fabric reinforcement in flat sheets.

Furnish bar mats and bars of structural or intermediate grade, as specified in the Contract.

Furnish all reinforcing steel meeting Subsection 711.01 requirements.

501.02.3 Dowel Bars and Sleeves. Furnish Grade 40 plain round dowel bars meeting AASHTO M 31 requirements.

Bar dimensions and placement in the pavement are specified in the Contract.

Do not use bars having burrs or other deformation that restrict slipping in the concrete.

Before delivery to the project, coat one-half the length of each dowel bar with one coat of zinc or tar paint. Furnish sleeves for dowel bars meeting the Contract requirements.

501.02.4 Tie Bars. Furnish ASTM A 615, Grade 40 deformed steel bars. The length, size, and spacing of the bars are specified in the Contract.

501.02.5 Expansion Joint Filler and Joint Sealing Material. Furnish expansion joint filler and joint sealing material meeting Subsection 707.01 requirements.

501.02.6 Curing Compound. Furnish AASHTO M 148 Type 2, white-pigmented, membrane-forming curing compound.

501.03 CONSTRUCTION REQUIREMENTS.

501.03.1 Equipment.

A. General. Do not begin paving operations until all equipment and tools for the pavement construction are available at the site.

Assure the equipment is in good mechanical condition, adjustment, design, and capacity.

Adjust, repair, or replace equipment failing to produce the specified work.

Use handling, batching, mixing, and concrete transporting equipment meeting the applicable requirements of Section 551 and the following.

Use batch plants for projects having 300 cubic yards (229.5 m^3) or more portland cement concrete pavement that proportion aggregates and cement by weight using automatic and interlocked proportioning devices.

Use non-agitating hauling equipment with smooth, mortar-tight metal bodies that completely discharge the concrete at a uniform rate without segregation. Provide covers when necessary to prevent the concrete from drying out or being exposed to weather-related moisture.

Use belly-dump trucks only with the Project Manager's written approval.

Remove and dispose of concrete remaining in haul units before reloading with fresh concrete.

B. Stationary Side Forms. Use metal side forms strong enough to resist displacement from concrete and mechanical equipment pressures.

Use flexible or curved forms for curves with 100 foot (30.5 m) radii or less.

Forms must:

1. Hold abutting sections in alignment;
2. Be adjustable for vertical and horizontal curvature;
3. Have a minimum depth equal to the specified concrete edge thickness;
4. Not have horizontal joints;
5. Have a base width greater than or equal to the depth;
6. Have at least 3 staking points for each 10 foot (3 m) of length that securely lock to the form stake;
7. Have flange braces and staking pockets that extend outward on the base at least two-thirds the height of the form.

Use wooden forms only with the Project Manager's written approval. Include in the request to use wooden forms complete details showing they meet the requirements for steel forms regarding strength, lines, grades, and depth.

Do not use forms in poor condition in the work. Repaired forms must be inspected and approved before use.

C. Placing, Consolidating, and Finishing Equipment. Place, consolidate, and finish concrete meeting the Contract requirements.

Operate only rubber-tired equipment on adjacent pavement. Pad crawler units to prevent pavement damage.

Keep the adjacent pavement and form tops clean to provide good contact with tires or crawler units.

1. **Slip-Form Pavers.** Use slip-form pavers having automatic controls for longitudinal and transverse grade from continuous wire control lines.

   Maintain the control wire tension, support interval, and sensor operating pressure to prevent control wire deflection in excess of 3/16-inch (5 mm) below supports at mid-span. Immediately stop paving operations when deflection exceeds 3/16-inch (5 mm) and resume once corrected.

   Use self-propelled slip-form pavers to place and finish the concrete that are capable of negotiating all grades without external tractive force.

   Equip the slip-form paver with an auger or other approved strike-off device to distribute the concrete to a uniform depth ahead of the screed.

   Use sliding forms that are laterally rigid to prevent spreading.

   Use slip-form pavers that consolidate the plastic concrete by internally vibrating the full paving width and depth. Use transverse vibrating units that do not project outside the specified paving section thickness and are positioned ahead of the screed a minimum distance equal to the pavement thickness. A series of longitudinal vibrating units may be used as an alternate. Vibrators may be the immersed tube type or a series of equally spaced longitudinal vibrating units.

   The maximum spacing of each unit in a series of longitudinal units is 24-inches (610 mm) measured center-to-center of the units.

   Each vibratory unit must provide at least 7000 vibrations per minute with the amplitude visibly perceptible on the concrete surface within 1 foot (305 mm) of the entire length of the vibrating unit. Equip the Paver with a tachometer or other approved device for measuring the actual vibration frequency.
2. **Auxiliary Finishing Equipment.** Use finishing equipment behind the slip-form paver that automatically maintains alignment from an external reference.

   Provide hand floats, edging tools, and other hand-finishing equipment to finish the surface as specified.
3. **Stationary Side Form Method.** Submit to the Project Manager details for all equipment proposed for spreading, strike-off, consolidating, screeding, and floating before use.
4. **Roadbed Planers.** Equip the roadbed planer with adjustable steel cutting edges mounted in a rigid frame to trim the roadbed to the specified elevation and crown under all operating conditions. The planer wheels must ride on the forms or adjacent pavement.
5. **Concrete Spreaders.** Use a self-propelled spreader that uniformly spreads the concrete between forms and has an adjustable blade or head for striking off the concrete to the required height and crown.
6. **Vibrators.** Use full-width concrete slab vibrators of the surface pan type or the internal type with immersed tube or multiple spuds.

   The vibrators may be mounted on the spreader, the finishing machine, or on a separate carriage.

   Do not allow the vibrators to come in contact with the joint load transfer devices, the sub-grade, or side forms.

Use surface vibrator's having a minimum frequency of at least 3,500 impulses per minute; tube vibrators with a minimum frequency of at least 5,000 impulses per minute; and spud vibrators with a minimum frequency of 7,000 impulses per minute.

Use hand-operated or machine-mounted spud-type internal vibrators next to forms having a minimum frequency of 3,500 impulses per minute.

7. **Bridge Deck Finishing Machines.** Use transverse-finishing rotating drum bridge deck finishing machines when stationary side forms are allowed.
8. **Mechanical Floats.** Use mechanical floats that produce a surface true to the required crown and smoothness, free from honeycomb or excessive mortar.

   Assure the float makes accurate incremental adjustments to the required crown without interrupting the float operation.

   The mechanical float may be self-propelled or attached to the rear of the transverse finishing machine.

501.03.2 Pre-paving Conference. Attend a pre-paving conference, conducted by the Department, to be held at least 24 hours before paving starts.

The conference topics will include equipment, construction methods, specification requirements, and lines of communication.

The conference must include the foreman, other contractor personnel that will supervise the concrete paving operations and key Department inspection personnel.

501.03.3 Aggregate Sampling and Testing. Furnish aggregates that meet the gradation requirements, fineness modulus, and deleterious material limits specified in Subsection 701.01. Provide all sampling and testing to meet these requirements during aggregate production.

501.03.4 Aggregate Production. Produce aggregate meeting the applicable requirements of Section 551.

Produce and stockpile at least one-third of the quantity of each size aggregate necessary to produce the plan quantity of portland cement concrete pavement before paving operations begin.

501.03.5 Acceptance of Aggregate.

A. **Sampling and Testing.** The Project Manager will determine when samples are taken and will test the aggregate for acceptance.

   Furnish and operate the aggregate sampling devices, witnessed by the Project Manager. Take samples at a point immediately before the aggregates are combined and enter the mixer, witnessed by the Project Manager. Samples may be split to a minimum 50 pounds (23 kg). Furnish the samples to the Project Manager immediately after sampling.

   Acceptance samples will be randomly selected.

   The approximate quantity represented by each sample is specified in MT-601.

   Additional samples may be selected and tested.

B. Lot Size. The concrete quantity in each day's production will constitute a lot whenever production schedules and material continuity permit.

The Project Manager may establish a lot consisting of the quantity represented by any number of consecutive random samples from 3 to 7 inclusive if the Project Manager determines it is necessary due to production runs, significant material changes, or other unusual characteristics of the work.

C. Acceptance. Portland cement concrete pavement is evaluated for price adjustment on a lot-by-lot basis under Subsection 105.03.2, when deviation from specified aggregate gradation limits, fineness modulus limits for fine aggregate, or percent passing the number 200 sieve (0.075 mm) for coarse aggregate occurs on one or more tests for a lot.

Payment for a lot where a price reduction applies under the acceptance provisions in Subsection 105.03.2 is calculated using the following formula:

Price Reduction = Contract Unit Price x 0.40 x P/100 x Lot Quantity

"P" is the percent reduction in contract price as defined in Subsection 105.03.2.

The Lot Quantity equals the plan quantity in cubic yards (cubic meters) or square yards (square meters) of the pavement section where the lot was placed.

501.03.6 Mixing. Mix concrete meeting Subsection 551.03.3 requirements.

501.03.7 Transporting Concrete. Transport concrete in equipment meeting Subsections 501.03.1 and 551.03.4 requirements.

501.03.8 Placing and Finishing Concrete. Place all portland cement concrete pavement for projects of 20,000 square yards (16,720 m^2) or more, or bridge approach slabs, ramp tapers, and other small, restricted, or irregular areas, by the slip-form method.

Construct projects with 20,000 square yards (16,720 m^2) or less pavement using the slip-form method or by stationary side-form method using bridge deck finishing equipment.

Submit the proposed procedures and equipment details for the side-form method for approval before paving.

Place the fresh concrete on the prepared roadbed as close as possible in front of the paving machine to minimize concrete handling. Do not routinely use front end loaders or other equipment at the paver for moving the fresh concrete once its placed on the roadbed.

Place concrete hauled in non-agitating equipment within 45 minutes from when the ingredients were charged into the mixer. Dispose of concrete that does not meet slump requirements at Contractor expense.

Place concrete hauled in agitator trucks within the time limits in Subsection 551.03.4(A).

Distribute the concrete to the specified slab thickness, with the finished surface at the specified grade, once the concrete is consolidated and finished.

Do not use vibrators to distribute concrete.

Place concrete only after the foundation course or sub-grade has been approved by the Project Manager.

Prepare the foundation course ahead of the paving operation equal to the anticipated daily production.

Place concrete around manholes or other structures once the structures are brought up to the required grade and alignment.

Dampen the base or sub-grade with a fine water mist immediately before placing concrete. Do not permit free-standing water to puddle on the surface.

If concrete placing is delayed or stopped in excess of one hour, construct an emergency transverse construction joint as directed.

Except for emergency transverse joints, do not construct a joint at any location other than as directed or specified.

Construct the pavement in full lane widths in a single operation.

Construct longitudinal joints between lanes or sections meeting Subsection 501.03.13(F) requirements.

Do not place concrete in longitudinal sections until the adjacent slab is 14 days old or has reached a minimum compressive strength of 2,000 pounds per square inch (13,800 kPa), determined by testing the standard cylinders cured under the same environmental conditions as the slab.

A. Slip-Form Method.

1. **General.** Place the concrete with a slip-form paver meeting Subsection 501.03.1© requirements that will spread, consolidate, screed, and float-finish the fresh placed concrete in one pass.

   Operate the slip-form paver to maintain a continuous, forward movement. Assure all concrete mixing, delivering, and spreading provides uniform progress without stopping and starting the paver. If it is necessary to stop the paver, immediately stop the vibrators and tamping.

   Maintain a uniform consistency in the concrete with a slump of 1 to 2-inches (25 to 50 mm).

   The paver may be set to form a 3-inch (75 mm) or less battered edge while maintaining the top riding surface at the specified width.

   Apply additional hand vibration at construction joints as required for consolidation.

2. **Straightedge Finishing.** After the concrete has been finished by mechanical finishing equipment, test for surface smoothness under Subsection 501.03.14 B.

   Use a straightedge at least 10 feet (3 m) long and a handle 3 feet (.9 m) longer than one-half the pavement width for the test.

   Test both parallel and at right angles to the centerline, and advance the straightedge along the pavement in maximum successive stages of one-half the straightedge length.

   Correct sections not meeting tolerances and continue the straightedge testing and finishing until the surface meets the surface smoothness requirements.

   The straight-edging requirements may be waived in writing by the Project Manager if it is demonstrated that the paving equipment will

consistently produce a surface meeting the surface smoothness tolerances.

Correct any pavement edge slump, excluding specified edging, exceeding 1/4-inch (6 mm) before the concrete has hardened.

If the edge slump on any 1 foot (305 mm) or longer length of hardened concrete exceeds 1-inch (25 mm), remove and replace the entire panel between the transverse and longitudinal joints.

Before the initial concrete set, round the pavement edges on each side of the transverse expansion joints, formed joints, transverse construction joints, and emergency construction joints to the required radius. Construct a well-defined, smooth, dense mortar finish radius.

Hand finishing is permitted only for finishing sections with narrow irregular dimensions and to finish any concrete already deposited on the grade should a machinery breakdown occur.

Grind high spots exceeding 1/4-inch (6 mm) using approved methods. Fill low spots exceeding 1/4-inch (6 mm) with an approved epoxy-bonded grout as directed.

B. Stationary Side Form Method.

1. **Preparation of Sub-grade or Foundation Course.** Once the roadbed is finished and compacted under Section 203, trim, shape, and compact the sub-grade or foundation course meeting Section 301 to the specified lines, grades, and cross sections.

   Extend the finished sub-grade 2 feet (610 mm) beyond each side of the planned pavement width.

   Once the forms are set, re-shape and re-compact all disturbed sub-grade or foundation course using rollers or compactors working between the fine grading equipment and the paver.

   Test the sub-grade or foundation course in advance of the paver for section and grade using an approved template. Mount the template on visible rollers with the tooth edge conforming to the required shape of the sub-grade when riding vertically on the forms. Remove excess material and fill low areas to the finish elevation with sub-grade or foundation material and compact to the specified density.

   Maintain the finished sub-grade or foundation course in a smooth, compacted, undisturbed condition until the pavement is placed.

   Moisten the sub-grade or foundation course as specified in Subsection 501.03.8 when placing the concrete.

2. **Form Setting.** Do not permit the forms to deviate more than 1/8-inch (3 mm) from the true plane of the form face or top. Do not permit the forms to warp, bend, or kink. Clean and oil forms before each use.

   Cut the compacted foundation course or the sub-grade to grade providing firm contact for each form for its entire length at the specified grade. Fill low areas to grade in ½-inch (13 mm) lifts or less for 18-inches (460 mm) on each side of the base of the form and compact to the specified density. Settlement or springing of forms under the finishing machine is not allowed.

   The forms will be checked for alignment and grade. Make any corrections before placing the concrete.

Correct unstable or disturbed forms or foundation courses and re-check the forms.

Prepare the foundation course and forms ahead of the paving operation equal to the average daily production.

Leave the forms in place at least 12 hours after the concrete has been placed unless earlier removal is necessary to permit sawing of transverse weakened plane joints. Exercise care in removing forms to avoid damage to the pavement edges.

3. **Strike-Off and Consolidation.** Strike off, screed, and consolidate the concrete with mechanical equipment to the specified crown and cross section providing a uniform surface texture. Avoid prolonged work over any area.

   Maintain a uniform ridge of concrete ahead of the front screed of the finishing machine except when making construction joints.
4. **Floating.** Following strike-off and consolidation, finish the concrete surface with a mechanical float under Subsection 501.03.1 (C)(8).
5. **Straightedge Finishing.** Once the concrete is finished with the mechanical finishing equipment, test the surface smoothness and make corrections under Subsection 501.03.8(A)(2).

C. **Final Surface Finish.** Produce the final surface finish by a light burlap drag longitudinally followed by transversely grooving the concrete to an approximate 1/8 to 3/16-inches (3 mm to 5 mm) deep.

Produce the grooves using mechanical equipment having square or circular spring steel tines 0.08-inch (2 mm) square or in diameter spaced on 3/4-inch (19 mm) centers.

Meet an average surface texture of from 0.035 (1 mm) to 0.060-inch (1.5 mm), as measured by MT-113 (sand patch test).

Use steel-tined hand rakes for the final surface finish for narrow, irregularly shaped ramp taper sections.

Use hand grooving methods that match that of mechanical equipment.

Produce the final surface finish of bridge approach slabs by either mechanical equipment or steel-tined hand rakes.

If the repair of high spots or low spots results in surface texture loss, re-groove the affected area to the specified texture at Contractor expense.

501.03.9 Protection of Concrete From Rain. Maintain materials at the project site to protect all un-hardened concrete surfaces from rain.

When rain appears imminent, stop paving operations and cover all surfaces of the un-hardened concrete with the protective covering.

501.03.10 Evaluation and Repair of Rain-Damaged Concrete. Follow The American Concrete Paving Association Technical Bulletin No. 17 for the evaluation of and acceptable repair methods for rain-damaged concrete.

All protective, remedial, and corrective work to produce acceptable pavement is at Contractor expense.

501.03.11 Curing.

A. Membrane. After the concrete is finished and the free water has left the surface, seal the entire surface area by machine spraying a uniform application of curing compound meeting Subsection 501.02.6 requirements.

Apply the curing compound following the manufacturer's recommendation's before surface hair checking develops.

Do not apply curing compound to the inside faces of joints to be sealed.

If the groove coverage is not complete after the first application, apply a second coverage in the opposite direction from the first. Apply the second application within 30 minutes of the first application.

Assure the equipment controls the curing compound application rate and uniformity. Use the coverage rate of 1 gallon per 150 square feet (0.27 L per m^2) or follow the manufacturer's recommendations.

Re-apply membrane curing compound to areas protected for less than 72 hours and that are damaged by sawing, rain, or other causes.

B. Other Methods. The Contractor may submit for approval, other curing methods.

501.03.12 Handling and Placing Reinforcement. Keep reinforcing steel clean, rust free, straight and distortion free, placed and held in position as specified.

Store reinforcing steel out of the weather, distributing only the steel needed for immediate placing along the work.

Assemble and place reinforcement for bar mats as specified. Maintain bar mat placement during concreting operations. Tie all intersections. Lap all adjacent ends at least 40 bar diameters.

501.03.13 Joints.

A. Transverse Expansion Joints. Construct transverse expansion joints as specified in the Contract.

B. Expansion Joints at Structures. Construct and seal joints between concrete approach slabs and structures or concrete pavement as specified.

C. Transverse Construction Joints. Make transverse construction joints as detailed in the Contract, at the end of each day's run, or where concrete work is interrupted for more than one hour.

Form the joint using a clean plank cut to the plan cross section with an attached beveled strip to form a key-way. Remove the header and clean excess concrete on the sub-grade and joint face before placing fresh concrete against the joint.

D. Transverse Contraction Joints. Saw transverse contraction joints to the specified width, depth, and spacing using a power-driven gang saw with at least 4 separate blades.

Saw initial or "control" transverse contraction joints at 54 foot (16.5 m) intervals or another multiple of the specified joint spacing that reduces uncontrolled cracking with the least number of initial contraction joints. Saw initial contraction joints as soon as possible after the concrete is placed. Do not permit the saw to tear or ravel the adjacent concrete. Saw the remaining contraction joints typically within 24 to 48 hours after concrete is placed.

Be responsible for determining joint-sawing methods, sequences, and timing to prevent random cracking. Immediately revise methods that cause random cracking. Repair or replace concrete defects resulting from errors in the work methods at Contractor expense.

Repair or replace broken slabs, random cracks, nonworking contraction joints near cracks, and spalls along joints and cracks under Subsection 501.03.15.

Protect saw cuts in concrete 60 hours old or less from rapid drying using twisted paper, fiber or rope cords, waterproof covering, or other approved methods.

Have at least one stand-by saw in good condition and additional saw blades at the job site during sawing operations.

Cut curbs and gutters to the required depth to prevent erratic cracking.

Immediately after the joints are sawed, flush the groove with pressurized water and blow the groove out with compressed air to remove all dust, water, and slurry. Clean the groove using compressed air just before filling with joint filler.

Place hot-poured joint sealer in sawed joints to within 1/4 (6 mm) to 3/16-inch (5 mm) of the pavement surface when the pavement temperature is at least +40 °F (4 °C).

Do not use polyethylene strips to form transverse contraction joints.

E. Longitudinal Joints. Saw longitudinal joints to the specified width and depth within 3 days of placing the concrete.

Do not use plastic tape as a joint sealer.

Saw and apply hot-poured joint sealer meeting Subsection 501.03.13(D) requirements.

Assure the finished joint alignment is parallel to the centerline of the pavement and does not have irregularities exceeding 0.04 foot (12 mm), measured by a 12 foot (3.6 m) straightedge, except for normal centerline curvature.

F. Key-way Longitudinal Joints. Construct key-way joints as specified when adjacent pavement slabs are constructed separately.

501.03.14 Surface Test. Test the pavement surface using one of the following tests.

A. Profilograph. Furnish a 25 foot (7.6 m) wheel base California type profilograph and a competent operator to measure the surface smoothness before joint sealing. Do not exceed a maximum 3 mph (4.8 kph) operational speed. Calibrate, adjust, and operate the profilograph following the manufacturers instructions and California Test Method 526. Provide the Project Manager 24 hours advance notice before using the profilograph. The Project Manager will witness all profilograph recordings. The profilogram must record a scale of 1-inch (25 mm) to 25 feet (7.6 m) longitudinally and 1-inch (25 mm) to 1-inch (25 mm) vertically. Take a profile on a line parallel to and 3 feet (0.9 m) inside the outside edge of each traffic lane. Run the profilograph parallel to the pavement edge at all times. Additional profiles may be taken to define the limits of an out-of-tolerance surface. End the profiles 50 feet (15.2 m) from existing pavements, bridge

ends, and intersections. The acceptable lane section profile is an average profile index of 12-inches (305 mm) per mile (1.6 km) or less with each lane section being 1/10 mile (161 m) long. The Project Manager will determine the profile index using California Test Method 526. Remove all high points in excess of 0.3-inch (8 mm) in 25 feet (7.6 m) or less within each 1/10 mile (161 m) section using a method approved by the Project Manager. Re-profilograph re-worked sections. All sections must have a maximum average profile index of 15-inches (380 mm) per mile to be accepted. Re-profile corrected areas to determine if the section has an average profile index of 15.

Contract unit price adjustments are made using the following schedule. The Contractor may elect to perform corrective work to reduce the average profile index when it is less than the corrective index but greater than the incentive index. Incentive will not be paid on sections with an initial index exceeding 15.

Lane Average Profile Index (Inches per mile-per 1/10 Mile)	**Contract Unit Price Adjustment**
Less than 6	$0.50 per yd² incentive pay
6 to 10	Contract Bid Price
10 to 15	$1.00 per yd² deduction
Over 15	Corrective work required

METRIC

Lane Average profile Index (mm per 1.6 km-per 161 m)	**Contract Unit Price Adjustment**
Less than 150 mm	$0.60 per 1 m² incentive pay
150 mm to 255 mm	Contract Bid Price
255 mm to 380 mm	$1.20 per 1 m² deduction
Over 380 mm	Corrective work required

The price adjustment will apply to the entire area of concrete for the 1/10 mile (161 m) lane segment. The area will be computed using plan width for the 1/10 mile (161 m) lane segments. Sections of pavement less than 1/10 mile (161 m) will be added to subsequent paving to provide a 1/10 mile (161 m) section.

No payment is made for any section with an average profile index exceeding 15 until it is re-worked and re-profiled to an average profile index of 15 or less. Re-work all areas not profilographed (50 feet (15.2 m) from bridge ends and intersections) with high points exceeding 0.3-inch (8 mm) in 25 feet (7.6 m) to 0.3-inch (8 mm) or less per 25 feet (7.6 m).

Complete all corrective work before measuring the pavement thickness.

Include all profilographing costs in the unit bid price for Portland Cement Concrete Pavement.

B. Straightedge. Use straightedge tests for sections of pavement less than 300 feet (91.5 m) in length. Once the concrete has hardened, test the pavement surface with a 10 foot (3 m) straightedge placed parallel to the pavement centerline.

Span each low spot and touch each high spot with the testing edge revealing all irregularities.

Correct all pavement showing a variation from the testing edge exceeding 1/16-inch (2 mm) per foot (305 mm) from the nearest contact

point with the testing edge or showing a total variation exceeding 1/4-inch (6 mm) from the 10 foot (3 m) straightedge by grinding until the areas are within the above limits.

Where the grinding methods would result in an unsatisfactory surface or in a slab thickness less than specified, the affected pavement may require an adjustment in unit price or removal and replacement under Subsection 501.03.20.

Perform all pavement corrections including removing and replacing of pavement at Contractor expense.

501.03.15 Correcting Spall and Cracks. Remove and replace pavement slabs cracked through the full depth into three or more parts.

Repair pavement slabs containing a single diagonal crack intersecting the transverse and longitudinal joints within 1/3 of the width and length of the slab from the corner by removing and replacing the smaller portion of the slab. Repair broken slabs as directed.

Groove and seal random cracks that penetrate the full depth of the pavement. Groove the top of the crack to 3/4-inch (19 mm) minimum depth and a width between 3/8-inch (10 mm) to 5/8-inch (16 mm) using an approved grooving machine. Use a vertical rotary-cutting machine that can follow the crack path and widen the top of the crack to the required section without spalling or damaging the concrete. Remove all loose and fractured concrete, and thoroughly clean and seal the groove with the sealant specified in the Contract.

The Project Manager will determine what random cracks are tight, don't penetrate the full depth of the pavement and will be left undisturbed. When requested by the Project Manager, determine the crack depth penetration by drilling and inspecting cores at Contractor expense.

When a transverse random crack terminates in or crosses a transverse contraction joint, fill the un-cracked portion of the joint with epoxy-resin mortar or grout, and route and seal the crack.

When a transverse random crack nearly parallels the planned contraction joint and is within 5 feet (1.5 m) from a contraction joint, route, seal, and fill the crack with epoxy-resin grout or mortar.

When a transverse random crack is more than 5 feet (1.5 m) from the nearest contraction joint in the pavement, seal both the joint and the crack. Thoroughly clean the joints before filling with epoxy-resin mortar or grout.

Repair spalls by making a saw cut at least 1-inch (25 mm) outside the spalled area and to a minimum depth of 2-inches (50 mm). When the spalled area abuts a joint, make a saw cut 2-inches (50 mm) deep or 1/6 the slab thickness, whichever is greater. Chip out the concrete between the saw cut and the joint or primary crack to solid concrete. Thoroughly clean the resulting cavity of all loose material. Apply

a prime coat of epoxy-resin binder to the dry, cleaned surface of all cavity sides, except the working joint faces to be retained. Apply the prime coat by scrubbing it into the surface with a stiff bristle brush. Place portland cement concrete or epoxy-resin concrete or mortar immediately following the prime coat application.

For spalled areas abutting working joints or working cracks penetrating full depth, place an insert or other bond breaker to maintain the joint or crack during the patch repair.

501.03.16 Opening To Traffic. Opening the pavement to traffic and the Contractor's vehicles is permitted when the longitudinal joints are complete and the compressive strength of 6 x 12-inch (155 by 305 mm) cylinders tested under AASHTO T 22 is at least 3,000 pounds per square inch (20,700 kPa) and the flexural strength of concrete beams (dimensions described in MT-101 of the Materials Manual) tested under AASHTO T 97 (ASTM C 78) is at least 500 pounds per square inch (3,450 kPa).

Place a temporary earth shoulder, or the permanent shoulder against the outside pavement edges before traffic is allowed on the pavement.

Opening to all traffic does not constitute a final acceptance of pavement.

501.03.17 Integral Curb. Construct the curb mono-lithically with the pavement.

Construct the inside face of the curb true to the lines and grades in the Contract using the finish specified for the concrete pavement, including longitudinal floating and burlap drag finishing.

Test the surface for longitudinal trueness with a straightedge while the concrete is still plastic. Meet the same surface requirements specified for the concrete pavement.

Continue concrete pavement joints through the integral curb at the same locations, of the same type, and constructed in the same manner.

Cure the integral curb as specified for concrete pavement.

501.03.18 Weather and Night Limitations. Place concrete at night only with the Project Manager's written approval.

Stop concrete work when the ambient temperature falls below 40 °F (4 °C) and do not resume until the ambient air temperature reaches 35 °F (2 °C) and is rising.

Do not place concrete on a frozen foundation course or sub-grade.

Remove and replace all concrete damaged by frost at Contractor expense.

501.03.19 Protection of Concrete. Cover the concrete with an approved commercial insulating blanket covering all pavement if the ambient temperature falls below 35 °F (2 °C) during the cure period. Leave in place for 7 days.

The Project Manager may direct the leaving the blanketing in place beyond the 7 day curing period.

501.03.20 Pavement Thickness. Construct concrete pavement to the specified thickness. Tolerances allowed for sub-grade construction and specifications that may affect thickness do not modify the thickness requirements.

A primary unit of pavement is the pavement area placed in each day's paving operations. Within a primary unit of pavement, there may be an area or areas that are determined to be a secondary unit or units of pavement, as specified in Subsection 501.03.20(B), Thickness Deficiency not exceeding 0.07 foot (21 mm). The primary unit area will be reduced by the secondary unit area.

Thickness measurements are made in each primary unit of pavement with a minimum one measurement for each 1,000 linear feet (305 m) of traffic lane, or fraction thereof, of pavement placed. The number of thickness measurements within each primary unit, both longitudinally and transversely, are determined by the Project Manager.

Thickness measurement locations are determined by random sampling under MT-416. Thickness measurements will be made using MT-106 to the nearest 0.01 foot (3 mm).

Pavement thickness variation is determined by comparing the actual thickness measured with the specified thickness. The variation is determined to the nearest 0.01 (3 mm) foot as either excess or deficient variation.

Secondary thickness measurements will be made under Subsection 501.03.20(B).

When portland cement concrete pavement is placed using wire-line control over a base course constructed under a previous contract, pavement thickness variation measurements are made from a taut string line placed transversely across the pavement between grade points for the wire-line controls. Measurements are made from the string line to the pavement surface at 3 points across the section. Deviations from the planned cross section are computed for each point. The deviations for the 3 points are averaged and represent the thickness variation for that section. Three random sections are measured for each 1,000 linear feet (305 m) of traffic lane, or fraction thereof, and are averaged to represent that portion of a primary unit.

These measurements are the thickness deviations for applying the requirements of Subsections 501.03.20(A) and (B).

Fill all remaining holes in the concrete pavement after the thickness measurements are made with concrete of the same quality as that used to construct the pavement, at Contractor expense.

A. Thickness Deficiency Not Exceeding 0.07 Foot (21 mm). If all of the deficient thickness variations in a primary unit do not exceed 0.07 foot (21 mm), the thickness variations in the unit will be averaged algebraically to determine the average thickness deficiency. For determining the average thickness deficiency, an excess thickness variation of more than 0.03 foot (9 mm) greater than the thickness specified is considered to be 0.03 foot (9 mm) greater than the specified thickness.

For each primary unit of pavement that is deficient in average thickness, pay to the Department, or the Department will deduct from any monies due or that may become due the Contractor under the Contract, a sum computed by applying the deficiency adjustment from Table 501-1 to the quantity of the unit.

TABLE 501-1
CONCRETE PAVEMENT THICKNESS DEFICIENCY

Average Thickness Deficiency		Proportional Part of Contract Price
Ft.	(mm)	Allowed
0.02	6	100%
0.03	9	80%
0.04	12	68%
0.06	18	57%
0.07	21	50%

For average thickness deficiencies of less than 0.02 foot (6 mm), no deficiency adjustment is made.

Average thickness deficiencies greater than 0.02 foot (6 mm) are rounded to the nearest 0.01 foot (3 mm) and the deficiency adjustment made using Table 501-1.

B. Thickness Deficiency Exceeding 0.07 Foot (21 mm). For each deficiency variation in a primary unit exceeding 0.07 foot (21 mm), the Project Manager will determine from secondary thickness measurements the dimensions of the secondary unit area where the apparent thickness deficiency exceeds 0.07 foot (21 mm).

The determination of the limits of the secondary unit area are made by making one randomly located secondary thickness measurement in each pavement panel adjacent to the panel in which the original measurement in the primary unit was made. This method will continue until the secondary unit area is bounded by panels in which the secondary measurement is deficient in thickness by 0.07 foot (21 mm) or less.

The secondary unit area is made up of entire panels only. Panels are the areas bounded by longitudinal and transverse joints and pavement edges.

If a transverse weakened plane joint has been omitted at the location where a volunteer crack exists, the volunteer crack is considered a transverse joint only if the adjacent pavement is not to be removed and replaced.

The Project Manager will determine within the limits of the secondary unit area, which panels will require replacement and which panels may remain in place using procedures (1) and (2) below:

1. At Contractor expense, remove and replace the deficient concrete pavement panels with new concrete meeting all Contract requirements. If the area to be removed is not bounded by longitudinal or transverse joints, saw the weakened plane joints at Contractor expense at the

locations designated by the Project Manager. Lower the sub-grade or base to meet the full thickness requirements. Replaced pavement will be tested for thickness requirements using additional secondary measurements and is subject to all of the Contract requirements.

2. The Contractor may leave deficient pavement panels in place if the panels meet all of the other Contract requirements and pay to the State 50% of the contract unit price per square yard (square meter) or cubic yard (cubic meter) for those pavement panels left in place, or the Department may deduct that amount from any monies due or that may become due the Contractor under the Contract. The decision to leave a deficient panel in place will be by contract modification under Subsection 105.03.

The cost of all secondary thickness measurements made under this Subsection will be deducted from any monies due or that may become due the Contractor under the Contract.

After eliminating the secondary unit area or areas and thickness measurements from consideration, the average thickness deficiency of the remainder of primary unit areas will be determined under Subsection 501.03.20(A). Secondary thickness measurements made outside of a secondary unit area will be used to determine average thickness variation in the remaining primary unit area in which the measurements are taken.

The Contractor is not entitled to any additional compensation or time extension due to these requirements.

If the Contractor believes that the number of thickness measurements made in primary unit areas by the Project Manager are insufficient to indicate the actual pavement thickness placed, the Contractor may request the Project Manager to take additional thickness measurements. The additional calculated variations will be averaged with the original variations to determine the average thickness variation.

The Project Manager will randomly select the location of all additional thickness measurements.

The cost of all additional measurements made will be deducted from any monies due or that may become due the Contractor under the Contract.

501.04 METHOD OF MEASUREMENT.

501.04.1 Square Yard Measurement. Portland cement concrete pavement is measured by the square yard (square meter) to the nearest 1/10 square yard (0.1 m^2).

The measured width is from outside to outside of completed pavement, not exceeding the specified width or the width ordered by the Project Manager.

The length is measured along the centerline of the pavement surface.

Fillets for widened sections or at drainage structures and similar locations placed monolithic with the pavement are measured as pavement.

Areas constructed other than as pavement are deducted from the pavement area. No deduction is made for any fixture located within the pavement limits that has a surface area in the plane of the pavement surface of 1 square yard (0.80 m^2) or less.

Integral curb is not measured for payment.

501.04.2 Cubic Yard Measurement. Portland cement concrete pavement is measured in cubic yards (cubic meters).

The concrete in cubic feet (cubic meters) per batch is calculated by determining the weight per cubic foot (cubic meter) of a batch using Montana Test Method MT-509 and dividing the result into the total accumulated weight of cement, aggregates, and water used in that batch.

The volume of concrete per batch is determined at least twice daily.

The volume per batch for each day's paving run is determined by averaging all volume determinations made that day.

The volume of concrete for payment for each day's run is the total number of batches accepted and placed multiplied by the volume per batch as outlined above.

501.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Cement Concrete Pavement	Square Yard (square meter) or Cubic Yard (cubic meter)

Payment at the contract unit price is full compensation for resources necessary to complete the item of work under the Contract.

SECTION 551
PORTLAND CEMENT CONCRETE

551.01 DESCRIPTION. These are the general requirements for designing portland cement concrete mixtures, the ingredients, mixing, placing, curing, testing and acceptance for all classes and uses of portland cement concrete.

Additional requirements and exceptions to these specifications may be found in other sections concerning the specific use of the portland cement concrete.

551.02 MATERIALS.

551.02.1 Cement. Furnish low-alkali portland cement meeting the requirements of AASHTO M 85 or ASTM C 150, Type I,II, III, IV, or V, as specified.

Furnish Type I,II, or III cement for Class "Pre" concrete.

Do not use Type II-A cement.

Use Type II cement when the type or types is not specified.

Furnish Portland cement meeting the following requirements:

1. A total alkali content not exceeding 0.6 percent, calculated as the percentage of sodium oxide (NaO) plus 0.658 times the percentage of potassium oxide (K_2O);
2. Use only one brand of any one type of cement on the Contract except by written approval from the Engineer. Different brands or grades, if approved, cannot be used alternately in any one pour;
3. Store all bulk cement in metal silos, bins, or other approved storage. Assure storage permits convenient sampling and inspection. Store all sack cement in weatherproof buildings or, if approved, in the open on raised platforms with waterproof covering. Partially set, caked or lumpy cement will be rejected.

551.02.2 Air-Entraining Agents. Add an air-entraining agent to the concrete mixture unless otherwise specified.

Obtain the Engineer's written approval for changes to the air-entraining agent.

Add an air-entraining agent to prestressed concrete when specified or directed.

A. Testing. Before using any air-entraining agent, submit test results from a certified laboratory documenting that the agent meets the requirements of AASHTO M 154 (ASTM C 260) for 7 and 28 day compressive strengths and provides freeze-thaw resistance. Tests for bleeding, bond strength, and volume change are not required.

Tests may be taken on material samples submitted by the Contractor for use on the project or on samples submitted and certified by the manufacturer as representing the air-entraining agent to be supplied.

B. Certification. The Contractor may, instead of meeting Subsection 551.02.2(A) requirements, submit certification from the manufacturer attesting that the proposed material meets AASHTO M 154 (ASTM C 260) requirements.

The Department will keep on file, the original certification, giving approval of the material for individual projects by memorandum. Submit a signed statement attesting that the product furnished is the product represented by the manufacturer's certificate. List the name of the product in each certification and Contractor's statement.

The Contractor is responsible for unacceptable results caused by the air-entraining agent.

An air-entraining agent proposed for use or previously approved for other projects, may be used after Department acceptance of the Contractor's certification stating the name of the approved agent.

A proposed air-entraining agent may be used as an approved agent if it has minor differences in concentration and after the Department's acceptance of a Contractor's certification stating the name of the agent and that no other admixture or chemical agent is present.

C. Re-testing. The air-entraining agent may re-tested as necessary.

When re-tested, the concrete cylinders with air entraining agent must reach at least 88% of the compressive strength of the concrete without the air-entraining agent.

The percent strength reduction is calculated from the average strength of at least 5 standard 6 by 12-inch (152 mm X 305 mm) cylinders of each concrete type made and cured using MT-101 and tested under AASHTO T 22.

The percentage of entrained air is determined by MT-102.

Air-entraining agents failing these requirements will be rejected.

D. Addition of Air-Entraining Agent. Add the approved agent or agents to the mixing water.

If an approved metering device is used, its use to control the quantity of air-entraining agent added is acceptable.

E. Adjustments. The aggregate weight specified in the mix design is adjusted for increased yield resulting from air-entrainment. No field adjustment can be made.

The Department's laboratory will make any adjustments required.

551.02.3 Admixtures. Use admixtures only with the Project Manager's written permission.

Admixtures are only approved with certified laboratory test results or satisfactory field performance records to support product claims.

Furnish admixtures meeting ASTM C 494 requirements.

Use admixtures as follows:

1. When a water-reducing admixture is used, the cement content may be reduced not exceeding 10% for all concrete classes except Class "AS", "DS", or "BD Modified". The resulting water cement ratio must not exceed 0.49 or 5½ gallons (21 L) per sack of cement. Compressive strengths must meet Table 551-01 requirements;
2. No admixtures containing calcium chloride are permitted;
3. Notify the Engineer of the type of admixture to be used. Mix designs will not be furnished until this information is received;

4. Introduce admixtures and air-entraining agents separately into the mix water. Do not combine these agents before introducing them into the mixing unit.

551.02.4 Epoxy Adhesives. Furnish epoxy adhesives meeting ASTM C 881 or AASHTO M 234 and ASTM C 883 requirements.

Paragraph 1.4.8 of AASHTO M 234 is amended to permit thinning of epoxy for use in sealing ground deck slab areas only.

Furnish coal tar epoxy coating meeting AASHTO M 200 requirements.

551.02.5 Water. Obtain the Engineer's approval of the water to be used in the concrete. Assure the water does not contain oil, acid, alkali, vegative substances and is not brackish or salty.

Questionable water will be tested by comparing the compressive strength of concrete cubes made with the water in question, against those of concrete cubes made with water of known quality.

The concrete cubes will be cast, cured, and tested for compressive strength under ASTM C 109.

551.02.6 Aggregate. Furnish aggregates meeting Subsection 701.01 requirements.

Store aggregates in compartmented bins, or other methods that separate the different aggregate sizes to prevent contamination. Suspend work for aggregate contamination until corrected.

Build up coarse aggregate stockpiles in successive horizontal layers not exceeding 3 feet (0.9 m) thick. Complete each layer before starting the next one. Re-mix segregated aggregate to the grading requirements at Contractor expense.

When ready-mixed concrete is furnished, the ready-mix company's stockpiled aggregates must meet the aggregate specifications. The Company must establish separate stockpiles for Department work if existing stockpiles do not meet specifications.

Do not use contaminated aggregate removed from stockpiles in the work.

551.02.7 Curing Compounds and Protective Coatings. Furnish concrete curing compounds and protective coatings and combination curing-protective coating compounds meeting Subsection 713.07 requirements.

551.02.8 Preformed Expansion Joint Fillers For Concrete. Furnish preformed expansion joint fillers meeting Subsection 707.01 requirements.

551.03 CONSTRUCTION REQUIREMENTS.

551.03.1 Classification. Concrete is classified as follows:

1. Concrete mixtures with prefixes "A" contain 1½"-inch (37.5 mm) size aggregate;
2. Concrete mixtures with prefixes "D" contain 3/4-inch (19 mm) size aggregate.

Concrete with prefixes "D" may be substituted for concrete with prefixes "A" when the mix design has been approved by the laboratory.

The following requirements govern:

A. Classes "A" and "D" Concrete. Classes "A" and "D" concrete are used for sidewalks, curbs, and slope protectors.

B. Classes "AD" and "DD" Concrete. Classes "AD" and "DD" concrete are used for all structural concrete.

Class "DD" concrete may be substituted for Class "AD" concrete with the Project Manager's written approval. Bid all structural concrete as Class "AD". If a substitution is made, changing back to Class "AD" must be requested in writing and receive the Project Manager's written approval.

C. Class "BD Modified" Concrete. Class "BD Modified" concrete is used for all superstructure concrete including deck slabs and barriers.

D. Classes "AP" and "DP" Concrete. Classes "AP" and "DP" concrete are used for concrete pavement on streets and highways.

E. Classes "AS" and "DS" Concrete. Classes "AS" and "DS" concrete are used for concrete deposited underwater that does not contain an air-entraining agent.

F. Class "Pre" Concrete. Class "Pre" concrete is used in all prestressed items.

G. Class "F" Concrete. Class "F" concrete is used for setting metal fence posts and braces and similar uses where high quality concrete is not necessary.

Obtain the Project Manager's approval for aggregates for Class "F" concrete.

H. Classes "AC" and "DC" Concrete. Classes "AC" and "DC" concrete are used for erosion control devices.

I. Class "NS" Concrete. Class "NS" concrete is used as a non-shrink backfill for utility cuts in paved roadway sections.

J. Air-Entrained Concrete. Use air-entrained concrete in all parts of structures, except for Classes "AS", "DS", and Pre" concrete.

Do not use an air-entrained portland cement.

1. **Air-Entraining Agents.** Add the approved air-entraining agent to produce an entrained air content within the specified limits for the particular class of concrete.
2. **Entrained Air.** Provide the required air content for each class of concrete shown in Table 551-1.

Testing for the percent entrained air will be by MT 102 using concrete samples taken just before incorporation in the work.

551.03.2 Composition of Concrete. Furnish the Project Manager with the names of proposed suppliers and locations of proposed aggregate sources upon receipt of the Notice of Contract Award. This information is not required for Class "F", "AC", or "DC" concrete.

Coordinate with the Project Manager for submitting samples for testing.

A. Design. Design the concrete mix as follows:

1. Follow the laboratory mix design for measuring the coarse aggregate, fine aggregate, and the minimum allowable cement volumes into each batch.

2. The Department will furnish a laboratory mix design for each class of concrete, specifying the minimum cement content, the quantity of fine and coarse aggregate, and the maximum quantity of mixing water, as shown in Table 551-1. Make written requests to the Project Manager to increase the cement content in the mix designs.

   The Contractor may submit concrete mix designs to the Project Manager for approval rather than using the Department-furnished mix designs. Have Contractor furnished mix designs be developed by qualified persons following procedures published by the PCA or ACI. Meet the requirements of Table 551-1 for aggregate sizes, minimum cement content, maximum water content, slump, and entrained air limits. Cement content may be increased above the specified minimum to enhance workability or compressive strength. State the design proportions in terms of aggregates in a saturated, surface dry condition, with batch weights adjusted to account for actual moisture content of the aggregates during use. Submit the proposed aggregate source and proportion computations. Submit contractor-furnished mix designs based on aggregates used on highway projects within 1 year for review and approval at least 14 days before use. Submit mix designs based on aggregates from new sources for review at least 33 calendar days before use.
3. Produce all classes of concrete with the required minimum compressive strengths and the minimum flexural strength for Classes "AP" and "DP" concrete. The cement content may be increased to a maximum of 8 bags per cubic yard (10.5 bags per m^3) if approved.
4. Proportion the materials following the approved mix design. If concrete will be placed by pumping, the Engineer may modify the mix design to aide pumping.
5. Use the approved mix design proportions, if the materials are furnished from the originally named sources and meet the specified requirements. Do not exceed the maximum water-cement ratio specified in Table 551-1 for each class of concrete.
6. Do not change the materials source without the Engineer's approval and an approved mix design.
7. Fly ash or Type IP cement may be substituted for portland cement provided the following requirements are met:
   a. Make the substitution at a minimum ratio of 1.2 parts of the substitute to 1 part of portland cement by weight. Do not exceed 20 percent replacement by weight of the total cement.
   b. Portland Cement meeting AASHTO M 85, Table 1, may be used in place of moderate heat of hydration cement where fly ash is substituted.
   c. Do not exceed a 0.53 percent water-cement ratio by weight for all concrete classes except Class " BD Modified ", which is 0.44 percent. For calculation purposes, the cement weight is the total weight of Type IP cement or Portland Cement and replacement fly ash.

d. The 28-day strength of the substitute mix must equal or exceed the 28-day strength of the original mix design.

The strength is determined by testing cylinders cast from trial batches of concrete produced from the two mix designs. Make 5 batches of concrete for each mix design. One cylinder from each of the 5 trial batches of the two concrete mixes will be tested. Equivalency is based on a Student-t distribution test of the difference between the means of 5 tests of each mix at a significance level of 95 percent.

The slump must be within 1-inch (25 mm) of the target value; the air content within 1 percentage point of the midpoint of the allowable range specified in Section 551.03, Table 551-1. Do not exceed the maximum water-cement ratio specified in **c.**

Provide the concrete testing using a certified independent laboratory at Contractor expense. Furnish the Project Manager the certified test results. The Department has the right to verify all test results before concrete production begins. Department mix design approval does not relieve Contractor responsibility to produce concrete of the specified strength.

Follow the above procedure for each concrete class containing a Portland Cement substitute proposed for use.

Do not begin concrete production of any concrete class until testing and satisfactory results for that concrete is complete.

B. Class "F" Concrete. Class "F" concrete is 1 part portland cement, 2 parts of clean, hard, sharp sand passing a #4 mesh (4.75 mm) screen, and 4 parts of clean, broken stone or gravel uniformly graded between the #4 mesh (4.75 mm) and 1 ½-inch (37.5 mm).

Proportion the materials by weight or volume as approved.

Class "A" or "D" concrete may be substituted for Class "F" concrete.

C. Classes "AC" and "DC" Concrete. Classes "AC" and "DC" concrete is low slump concrete meeting Table 551-1 requirements.

Use broken stone or gravel uniformly graded between the #4 mesh (4.75 mm) and the maximum size sieve and clean, hard, sharp sand passing the #4 mesh (4.75 mm) sieve.

Proportion the materials by weight or volume as approved.

Class "A" or "D" concrete may be substituted for Classes "AC" and "DC" concrete.

D. Class "BD Modified" Concrete. Produce Class "BD Modified" concrete meeting Table 551-1 requirements.

Furnish coarse aggregate meeting the gradation requirements for No. 2 coarse aggregate in Table 701-4 of Subsection 701.01.2, with 5 percent maximum passing the No. 8 (2.36 mm) sieve.

Use an approved water-reducing admixture, and a set-retarding water-reducing admixture in deck slabs when ambient temperatures are expected to exceed +60 °F (15 °C) during the pour. No reduction in cement content is permitted because of using the water-reducing admixture.

The minimum cement content in Table 551-1 may be increased to enhance workability at Contractor expense.

Changes in concrete or material sources to maintain compressive strengths may be made, subject to the Project Manager's approval, at Contractor expense.

E. Class "NS" Concrete. Produce Class "NS" concrete composed of the following:

Material	Weight per cu. yd. (kg)
Cement - 0.45 sack	42 lbs (19 kg)
Water - 39 gallons (147.6 L)	325 lbs (147.5 kg)
Coarse Aggregate	1700 lbs (771.8 kg)
Fine Aggregate	1845 lbs (837.6 kg)

Furnish coarse aggregate meeting Subsection 701.01.2 requirements and the number 2 gradation in Table 701-4. Furnish fine aggregate meeting Subsection 701.01.1 requirements. The fine aggregate has no fineness modulus requirement.

TABLE 551-1
CONCRETE PROPORTIONING TABLE

Class	Size of Coarse Aggregate, Square Mesh, Inches (mm)	Minimum Cement Content, 94-lb. Sacks Per CY (0.76 m³)	Indicated Compressive Strength 7-Day, PSI (MPa)	Minimum Required Compressive Strength 28-Day, PSI (MPa)	Maximum NetWater Content Per Bag of Cement, Gallons (liters)	Target Value for Slump, Inches (mm)	Tolerance Inches (mm)	Required Air Content, Percent
A	1½ (37.5)	5.5	1600 (11)	2400 (17)	6.0 (22.7)	2½ (60)	±¾ (20)	4-6
D	¾ (19)	5.5	1600 (11)	2400 (17)	6.0 (22.7)	2½ (60)	±¾ (20)	5-7
AD	1½ (37.5)	6.5	2000 (14)	3000[3] (21)	6.0 (22.7)	2½ (60)	±¾ (20)	4-6
DD	¾ (19)	6.5	2000 (14)	3000[3] (21)	6.0 (22.7)	2½ (60)	±¾ (20)	5-7
AS	1½ (37.5)	7.0	1600 (11)	2400 (17)	6.0 (22.7)	6 (150)	±2 (50)	—
DS	¾ (19)	7.0	1600 (11)	2400 (17)	6.0 (22.7)	6 (150)	±2 (50)	—
AP[1]	1½ (37.5)	6.0	2000 (14)	Note 3	6.0 (22.7)	1½ (40)	±¾ (20)	4-6
DP[1]	¾ (19)	6.0	2000 (14)	Note 3	6.0 (22.7)	1½ (40)	±¾ (20)	5-7
Pre[2]	¾ (19)	6.5	—	5000 (34)	—	—	—	—
F	1½ (37.5)	—	—	—	6.0 (22.7)	—	—	—
AC	1½ (37.5)	4.5	—	—	6.0 (22.7)	1½ (40)	±¾ (20)	—
DC	¾ (19)	4.5	—	—	6.0 (22.7)	1½ (40)	±¾ (20)	—
BD Mod	¾ (19)	6.5	—	Note 3	5.0 (19)	2½ (60)	±¾ (20)	5-7

NOTES:

[1] For concrete pavement, the 28-day flexural strength requirement is 500 psi (3.5 MPa) minimum, determined by AASHTO T9 (ASTM C 78).

[2] For prestressed beams, the minimum compressive strength at transfer of pre-stress is 4000 psi (28 MPa). The strength shown at transfer of pre-stress and the 28-day requirement are for standard beams and will vary with beam length and design. Check plans and specifications for each project.

[3] The minimum required compressive strength at 28 days listed in the table does not apply to Classes "AD" and "DD" concrete used in bridges and structures. The compressive strengths for acceptance for Classes "AD" and "DD" concrete used in bridges and for Classes "AP", "DP", and "BD Modified" concrete is that specified in Subsection 551.03.7(C)(1).

[4] The target value for slump may be reduced as necessary for concrete placed using slip-form methods.

551.03.3 Sampling, Handling, Batching, and Mixing. Produce each class of specified concrete from approved material batched in the proportions specified in the approved mix design.

Correct for moisture content variations. The fine and coarse aggregates are sampled using methods described in MT-201 using sample sizes used in MT-202.

The water may be proportioned by weight or volume. Proportion the cement, fine aggregate, and coarse aggregates by weight.

The Contractor may substitute approved volumetric measuring devices for weighing devices when batching aggregates for structures containing less than 10 cubic yards (7.65 m^3) of concrete.

Obtain the Engineer's approval of weighing methods before starting batching operations.

A. Water.

1. **Weigh Measurement.** Assure the weigh equipment measurements are not affected by pressure variations in the water supply lines. The Project Manager may require an auxiliary tank for filling the weighing tank.
2. **Metering.** Measure water volume by metering through a recording water-meter device, accurate to within plus or minus 1 percent of the required volume or plus or minus 1 gallon (3.8 L), whichever is greater.

   Meter water for batching and mixing during warm weather operations.

   The Project Manager may permit alternate methods of water measurement for cold weather work.

   Completely discharge wash water from the mixer before starting any batching operation.

B. Cement and Aggregate. Proportion cement and aggregate by weight on all projects exceeding 50 cubic yards (38 m^3) for all classes of concrete.

Assure equipment for weighing cement and aggregates is accurate to within 0.5 percent of the true weight.

Weigh aggregates to within 1.5 percent of the total aggregate batch weight.

Weigh cement or fly ash to within 1.0 percent of the total cement batch weight. Weigh cement separately.

Equip scales for manual operation with a telltale dial or other device to show at least the last 50 pounds (23 kg) of load.

C. Batching Plant. Equip the batching plant with separate bins, weighing hoppers, and scales for fine aggregate and each size coarse aggregate.

If bulk cement is used, include a bin, hopper, and separate scale for the cement. Seal and vent the cement weighing hoppers to prevent dust escaping to the atmosphere.

Equip the batching plant with a non-resettable batch counter that indicates the number of batches proportioned.

A single weighing hopper with an accumulative scale is permitted if a separate scale is used for weighing the cement.

Batch plants will meet the requirements of having a separate scale for weighing the cement if:

1. The cement is always weighed in a separate inner hopper of standard manufacture design; and
2. The cement is always batched and weighed first in the batching sequence;
3. Batch fly ash separately by weight.

For projects exceeding 20,000 square yards (16,720 m^2) of Portland Cement Concrete Pavement, proportion aggregates and cement with equipment that weighs and records batch weights automatically.

Provide the Project Manager a printed record of each batches: weight for aggregate; cement; fly ash; volume of water and admixtures; the time mixing began; time batch discharged; haul unit number; and percent moisture in aggregate. The automatic batching equipment above may be used for smaller concrete volumes.

Provide each scale installation with 10 standard 50 pound (23 kg) test weights.

Locate the aggregate sampling device at the nearest practical point the aggregates enter the batching weigh bins. Obtain the Project Manager's approval of the sampling device before batching operations begin.

D. Mixers. Use mixers that combine cement, aggregates, water, and admixtures within the specified time to form a uniformly mixed mass.

Operate mixers following the manufacturers recommendations.

Assure the manufacturer's plate is prominently displayed on the mixer showing the drum capacity in volume of mixed concrete.

Repair or replace mixer blades worn more than 3/4-inch (19 mm) from the design dimensions.

Clean hardened concrete from the drum. Do not intermingle batches.

Uniformity tests on three consecutive batches will be performed on samples taken after 15% and 85% of the batch is discharged.

Table 551-2 specifies the maximum permissible variations in test results on samples from the two different portions of the same batch.

TABLE 551-2
ALLOWABLE BATCH VARIATIONS

Air Content - Volume, percent of concrete	1.0
Slump - Inches	1.0 (25 mm)
Coarse Aggregate Content - Portion by weight of each sample retained on a No 4 sieve (4.75 mm), Percent	6.0
Average compressive strength at 7 days for each sample based on average strength of all comparative test specimens, Percent (two cylinders will be molded and tested for each sample)	7.5

Concrete is acceptable if test results in 2 out of 3 batches meet the limits for 3 out of the 4 tests.

Provide the facilities for sampling and arrange schedules for the sampling and testing.

Dump all concrete mixed less than the specified time outside the work or remove if incorporated, at Contractor expense.

Do not mix, transport, or place concrete using equipment with aluminum or aluminum parts that contact the concrete.

Concrete may be mixed in central plant mixers or in truck mixers meeting the following requirements:

1. **Central Plant Mixers.** Equip central plant mixers with an approved timing device, that automatically locks the discharge device when the drum is charged and releases the lock at the end of the required mixing period. The lock must have an audible warning device, which signals each time the lock is released.

   If the locking and timing device fails, the mixer may be used temporarily, provided the mixing time is increased 50% by using a clock or watch with a second hand located within full view of the mixer operator. Repair or replace the timing device within 3 working days.

   Equip mixers to have a positive mechanical device to prevent adding aggregate after the drum has been charged and mixing has begun.

   Mixing time for central plants is 90 seconds. The required mixing time may be reduced if the plant is capable of producing a homogeneous mix in a shorter time. Reduced mixing time will be approved only if uniformity tests meet Subsection 551.03.3(D) requirements.

2. **Truck Mixers and Agitators.** Use truck-mounted mixers having a closed, watertight revolving drum fitted with blades that thoroughly mix and completely discharge the concrete without segregation.

   Assure the manufacturer's plate showing the rated mixing, agitating capacity and the rated drum speeds for mixing and agitating is attached to the truck mixer and is legible.

Equip truck mixers with an accurate revolution counter that registers the drum revolutions. Mount the counter so it is easily read by both the operator and inspector.

Equip truck mixers with a water-metering device that is accurate to within plus or minus 1% of the required volume or plus or minus 1 gallon (3.8 L), whichever is greater.

The truck mixer metering device is not required if all batch water is added at the plant or other location through an approved metering device.

Operate the drum at the manufactures recommended speeds.

Introduce water, cement, and aggregates at a central plant and add aggregates into the mixer in any sequence that produces a concrete meeting all Contract requirements. Batch cement and water simultaneously.

Water may be added at the job site provided its introduction is witnessed by an inspector and the specified water-cement ratio is not exceeded.

If water is added at the job site, provide at least 20 additional mixing revolutions each time water is added before discharge.

Begin mixing immediately after introducing the cement and water and continue for at least 70 revolutions at mixing speed.

Assure at least 100 drum revolutions exceed 6 revolutions per minute. All revolutions exceeding 100 must be at agitating speed.

Keep the drum revolving continuously after the cement and water are introduced until it is discharged.

Do not use mixed concrete that has remained in the truck mixer drum longer than 10 minutes without agitation.

Concrete may be partially mixed by central plant mixing and completed by truck mixing. Central plant mixing must meet the requirements of Subsection 551.03.3(D)(1), except that the central plant mixing time may be reduced to 30 seconds. Continue the additional truck mixing between 50 and 80 drum revolutions at mixing speed.

E. Hand Mixing. Approval may be given to hand mix batches not exceeding 1/2 cubic yard (0.4 m^3) provided:

1. The hand mixing is performed on watertight platforms or containers;
2. The sand is spread evenly over the platform;
3. The cement is uniformly distributed over the sand and the two ingredients are thoroughly mixed dry using shovels until the mix is uniform in color.

Form the mix into a "crater", add water, turn and slice the entire mass until a uniform consistency is obtained.

Thoroughly wet the coarse aggregate, add it to the mortar, and turn and re-turn the entire mass at least 6 times until all aggregate is thoroughly covered with mortar and the mix is uniform in color and appearance.

Do not place hand mixed concrete underwater.

551.03.4 Transporting Concrete. Assure that the capacity of the plant and transportation equipment provide a delivery rate to permit handling, placing, and finishing of the work.

Time the delivery of loads to prevent the in-place concrete from taking initial set before succeeding layers or lifts are placed. Do not permit any layer or lift of concrete to remain exposed in excess of 20 minutes before being covered by fresh concrete.

Document the method and time of delivery by plant slips issued to the driver and signed by the Inspector at the plant. Deliver the slip to the Project Inspector upon arriving at the project.

A. **Revolving Drum Mixers.** Transport concrete in revolving drum mixers meeting Subsection 551.03.3(D)(2) requirements.

Discharge the concrete at the job and place it in final position within 1½ hours after introducing the mixing water and cement.

When the ambient temperature is 85 °F (29 °C) or above, place the concrete in final position within 1 hour after the water and cement are introduced.

B. **Non-agitating Transportation Equipment.** Do not use non-agitating transport equipment to transport concrete except when placing concrete pavement under Section 501.

551.03.5 Placing Concrete. Assure all reinforcement and other embedded items are clean and free from dried mortar, rust, scale, oil, or foreign matter before placing concrete.

Keep untreated forms and existing concrete in contact with fresh concrete wet at least 1 hour before placing the concrete.

Wash treated forms with a water spray immediately before placing the concrete.

Place concrete meeting the applicable requirements of Sections 501, 552, and 553.

Compact concrete into final position and consolidate it around fittings and embedded items.

Do not place Fly ash or Type IP concrete cement in different parts of the same structure before obtaining the Project Manager's approval. Demonstrate that such use will not result in noticeable color changes or appearance.

551.03.6 Curing Concrete. Protect exposed concrete surfaces from premature drying by covering it with canvas, plastic sheets with sealed joints, burlap, sand, or other materials. Keep the concrete moist. Continually moisten uncovered surfaces by misting.

The concrete surfaces against forms may be cured by leaving the forms in place for at least 7 days.

Protect concrete against freezing or other conditions harmful to strength development under the applicable requirements of Sections 501, 552, and 553.

To aid finishing, side forms on ornamental work, curbs and sidewalks, railings, and parapets may be removed between 12 and 48 hours after concrete placement.

Continue moist curing while finishing the concrete.

Keep the concrete surfaces moist after removing forms until surface repair is completed and one of the final cure methods described below is used. Surface

repair includes removal of irregularities and repair of all depressions, voids, and air holes.

Cure concrete for at least 7 days after the concrete is placed by either of the following methods.

A. Water Curing. Keep all finished top surface concrete moist with a fine water mist until the concrete has set. Keep the moist concrete wet with water or an approved curing cover.

Cure concrete deck slabs and concrete floors by placing burlap, cotton mats, or other absorptive material behind the finishing operation as soon as possible without marring the finished surface. Keep the absorptive material moist while in place.

The absorptive material may be kept in place for the entire curing period, or it may be removed as soon as practical and the entire surface covered with approximately 1½-inches (40 mm) of sand, kept moist for the entire curing period.

B. Impervious Membrane Curing. Use Type 2 white-pigmented membrane curing compound on deck slabs and portland cement concrete pavements.

Use Type 1-D clear membrane curing compound with a translucent fugitive dye for other surfaces.

Deliver membrane curing compound to the job in the manufacturer's original container, clearly labeled with the manufacturer's name and the contents.

Furnish clear curing compound, transparent and free from permanent color.

The clear compound must contain a fugitive dye that makes the film visible on the concrete for at least 4 hours after application but does not affect the concrete surfaces natural color after curing.

The compound must be ready to use as shipped by the manufacturer. Do not dilute the compound.

Do not use curing compound without providing the Project Manager a manufacturer's certification.

Pressure apply the curing compound, spraying it over the entire exposed surface in a minimum uniform film of one gallon per 150 square feet (0.27 L per square meter) of concrete surface. Pressurize the curing compound to produce a fine mist on the concrete during application.

Apply the curing compound immediately after the concrete finishing is completed.

If it is necessary that workers or equipment be on the concrete surface before the 7 day curing period is complete, cover the sealed surface with a protective cushion. Use a cushion of moist, 1-inch (25 mm) minimum thick layer of fine sand or sufficient layers of moist burlap to prevent damage to the finished concrete. Cover the cushion with 4 feet by 8 feet (1220 mm by 2440 mm) sheets of ¾-inch (20 mm) plywood. Do not place the cushion material until the final application of curing compound has been in place for 8 hours.

Alternate cushion material may be approved by the Project Manager in writing. Layers of plastic, visqueen, or canvas are not permitted.

C. **Application of Combination Curing and Protective Coating Compounds.** When specified, uniformly apply a combination curing and protective coating compound meeting Subsection 713.07 requirements over horizontal surfaces such as pavements, bridge deck slabs, concrete floors, and sidewalks.

Use white-pigmented compound for pavements or deck slabs.

Use a clear compound containing a fugitive dye on curbs, sidewalks, barrier rail, and other superstructure components.

Thoroughly mix and apply the compound following the manufacturer's instructions or apply at a rate exceeding 1 gallon per 150 square feet (0.27 L per m^2).

Apply the curing compound immediately after the finishing operation using a self-powered machine with a mechanical pressure distribution system to provide uniform coverage. Equip the spray nozzles with hoods during windy conditions.

A hand-operated sprayer providing uniform coverage may be used to apply liquid curing compound to areas where a self-powered sprayer is impractical.

If the curing membrane is damaged from any cause during the curing period, re-coat the damaged areas immediately.

551.03.7 Testing and Acceptance of Concrete.

A. Compressive Strength Testing.

1. **General.** A compressive strength sample consists of 3 test cylinders made at the same time from the same batch of concrete.

   The Contractor may make additional cylinders to determine strength gain and to maintain job control.

   Standard compressive strength tests will be made at 7 and 28 days, except as specified below for concrete used in prestressed members and for Class "BD Modified" concrete.

   The compressive strength results from one or a combination of the cylinders tested will determine if the concrete meets the required compressive strength in Table 551-1.

   Test cylinders will be cast and cured using MT-101 and tested under AASHTO T 22.

2. **Prestressed Concrete Members.** Standard compressive strength tests for Class "Pre" concrete will be made at 28 days. The average strengths of the three 28-day cylinders will determine acceptance under Subsection 551.03.7(C)(2).

   The Contractor may make additional cylinders for determining strength gain and to maintain job control.

3. **Class "BD Modified" Concrete.** Standard compressive tests for Class "BD Modified" concrete will be made at 7 and 28 days. The average strengths of two 28-day cylinders will determine acceptance under Subsection 551.03.7(C)(1).

B. **Flexural Strength Testing.** In addition to the above compressive strength requirements, Classes "AP" and "DP" portland cement concrete pavement will require beam tests to determine the concretes flexural strength.

The number of flexural strength tests required for acceptance is determined by the Department on a random basis. The flexural strength results from one or a combination of the beams tested will be used to determine whether the concrete meets the required flexural strength specified in Table 551-1.

Flexural beams made in the field will be cast and cured using MT-101 and tested under AASHTO T 97 (ASTM C 78).

C. Acceptance of Concrete. The concrete must meet all other specifications and the following:

1. Classes "AD", "DD", "BD Modified", "AP", and "DP" Concrete. These classes of concrete placed in bridges and in concrete pavement are evaluated for acceptance on a lot-by-lot basis.

The concrete quantity placed in a single day is divided into lots of equal quantity under Table 551-3.

TABLE 551-3
CONCRETE LOT QUANTITIES

Classes "AD", "DD", and "BD Modified"	Classes "AP" and "DP"	No. of Lots
100-199 Cu Yd (76.5-152 m^2)	100- 999 Cu Yd (76.5-152 m^2)	1
200-399 Cu Yd (153-305 m^2)	1000-1999 Cu Yd (765-1529 m^2)	2
400-599 Cu Yd (306-458 m^2)	2000-2999 Cu Yd (1530-2294 m^2)	3
600-799 Cu Yd (459-611 m^2)	3000-3999 Cu Yd (295-3059 m^2)	4
800-999 Cu Yd (612-764 m^2)	4000-4999 Cu Yd (3060-3824 m^2)	5

Lots for concrete volumes less than 100 cubic yards (76.5 m^3) in a single day will be formed by combining the quantities for each 2 successive placements.

Two sets of standard 6 x 12-inch (152 X 305 mm) compressive test cylinders will be made for each lot. Each set will be made from a sample taken from a single batch or load selected at random from all loads or batches in the lot.

Each set will consist of 1 cylinder for Classes "AD", "DD", "AP", and "DP" concrete and 2 cylinders for Class "BD Modified" concrete.

Cylinders will be cast and cured using MT-101 and tested under AASHTO T 22.

Each set of cylinders are tested for compressive strength at 28 days. The test results for 2 cylinder sets will be the average of the strengths of the individual cylinders.

The strengths of other cylinders made from the sample and tested at earlier ages are not considered for acceptance.

The lot acceptance strength is the average of the test results for the lot.

Each lot is accepted or rejected based on the lot acceptance test strength. The pay factor for each lot accepted is determined from the following table.

TABLE 551-4
PAY FACTORS

LOT ACCEPTANCE STRENGTH - PSI (1 psi= 6.9 kPa)

Class	1.0	0.95	0.85	0.70
AP,DP,AD,DD	3400 or >	3100-3399	2900-3099	<2900
BD Modified	3900 or >	3500-3899	3300-3499	<3300

The Contractor may request acceptance of a lot at the 0.95 and 0.85 pay factor in lieu of approved corrective work or removal and replacement.

Acceptance at the 0.70 pay factor instead of approved corrective work or removal and replacement will be based on the Engineer's determination of the effects the defective lot will have on structural integrity and durability specified in Subsection 105.03.

The concrete quantity in each accepted lot is paid for at the contract unit price multiplied by the appropriate pay factor in Table 551-4.

The lot quantity for pay factors less than 1.0 is computed from:

a. Plan neat line dimensions of the portions of the bridge or bridges where the lot was placed; or

b. The plan area in square yards (square meters) of the section of pavement in which the lot was placed.

2. Class "Pre" Concrete. Class "Pre" concrete is evaluated for acceptance on a lot-by-lot basis based on the average of the 28-day compressive strength cylinders and variation in test results as measured by the standard deviation.

Each lot will be judged against the formula, $\bar{X}$ - F'c + 0.35S.

Where:

$\bar{X}$ is the average of three 28-day cylinder strengths.

S is the standard deviation of the strengths for the three 28-day cylinders.

Fcc is the concrete strength required for final acceptance as specified in the Contract.

A lot is defined as all the concrete that is placed in a single pre-cast prestressed member.

Lots with any actual $\bar{X}$ less than $\bar{X}$ calculated from the above formula will be rejected.

Three 28-day compressive test cylinders will be made for each lot, and each 28-day test cylinder sample will be selected on a random basis from all batches or loads.

The strengths of other cylinders made from a sample and tested at an earlier age will not be considered for acceptance purposes.

The cylinders for acceptance will be cast under MT-101, sampled under MT-111 and tested under AASHTO T 22.

The cylinders will be cured within the curing enclosure under the exact conditions and methods used to cure the prestressed member until transfer of pre-stress. After transfer of pre-stress, the cylinders will continue curing under MT-101.

3. **Classes "A", "D", "AS", and "DS" Concrete.**
   - **a.** The average of all the 28-day strength tests representing each class of concrete, as well as the average of any 5 consecutive 28-day strength tests representing each class of concrete, must be equal to or greater than the required compressive strength.
   - **b.** Not more than 1 test in 10 consecutive tests may fall below 90 percent of the required compressive strength.
   - **c.** On projects where less than 10 tests are made, not more than 1 test may fall below the required compressive strength. The average of all tests must be equal to or greater than the required compressive strength, and paragraph (d) below will not apply.
   - **d.** Not more than 10 percent of all compressive strength tests may fall below the required compressive strength for each class of concrete used in each major structure.
   - **e.** Concrete represented by tests that fail to meet the requirements of paragraphs (a), (b), (c), and (d) will be rejected, unless it can be established by other methods that the concrete is acceptable in place in the completed structure. Procedures to evaluate in-place concrete that has failed one of the above requirements will be approved by the Engineer. Submit these procedures in writing within 7 days after the last compression test representing the specific member. Include in the written procedure details of sampling methods, including sample locations, test methods and conditions, and proposed criteria to evaluate test results. Generally, nondestructive test methods such as the Swiss hammer and the Windsor probe will not be considered. The evaluation procedure must be approved in writing before any sampling or testing of concrete in-place.
   - **f.** Unsatisfactory concrete will be rejected. Remove and replace all rejected concrete at Contractor expense.
4. **Small Concrete Quantities.** The Project Manager may accept 7 cubic yards (5.4 cubic meters) or less of 3,000 psi (20.7 MPa) strength concrete without a formal mix design. Submit a batch proportioning sheet to the Project Manager for approval before use. Class "BD" concrete is excluded from this exception. Furnish concrete under this exception meeting the slump requirements in Table 551-1.

551.04 METHOD OF MEASUREMENT. Concrete is measured by the cubic yard (cubic meter) under Subsection 552.04, unless otherwise specified.

Classes "AP" and "DP" concrete is measured for payment under Subsection 501.04.

Concrete used in pre-cast concrete products is measured for payment under Subsection 554.04.

Class "Pre" concrete is measured for payment under Subsection 553.04.

551.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Concrete	Cubic Yard (cubic meter)

Concrete is paid for at the contract unit price per cubic yard (cubic meter) under Subsection 552.05.

Classes "AP" and "DP" concrete is paid for under Subsection 501.05.

Concrete used in pre-cast concrete products is paid for under Subsection 554.05.

Class "Pre" concrete used in prestressed concrete members is paid for under Subsection 553.05.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 552
CONCRETE STRUCTURES

552.01 DESCRIPTION. This work is constructing concrete structures, and portions of prestressed concrete, steel, timber, stone masonry, and composite structures.

552.02 MATERIALS. Furnish materials meeting the following Section and Subsection requirements.

Concrete	Section 551
Reinforcing Steel and Structural Steel	Section 711
Expansion Joint Filler	Subsection 707.01
Water Stops	Subsection 707.03
Compression Joint Seals	Subsection 711.15
Fiber-Reinforced Pads for Bearing Plates	Subsection 711.16

552.03 CONSTRUCTION REQUIREMENTS.

552.03.1 General. The classes of cast-in-place concrete used in bridge substructures, retaining walls, and superstructures are as follows:

A. Class "AS" or "DS" for foundation seals and other underwater placement;
B. Class "AD" or "DD" for retaining walls, substructure to the beam seats, backwalls, and diaphragms;
C. Class "BD Modified" for deck slabs, curbs, sidewalks, and barriers.

552.03.2 Foundations. Construct foundations meeting Section 209 requirements. Place concrete only after the foundations are inspected and approved.

552.03.3 Falsework. Construct falsework that will support the concrete work without detrimental deformation or settlement and to the plan lines and grades.

Use piling to support falsework not on solid footings.

Temporary camber all spans allowing for shrinkage and settlement. The Contract specifies those bridges that require a permanent camber.

Provide "Tattletales" or other approved devices at locations to indicate form settlement or deflection. Adjust falsework as required to maintain plan line and grade.

Stop the work if detrimental settlement occurs in the falsework that cannot be adjusted. Remove and replace all concrete work affected by detrimental settlement at Contractor expense.

The Contractor is responsible for the adequacy and execution of the falsework plans. Furnish a Contractor approved copy of the falsework plans to the Project Manager upon request. The Contractor approval must be shown on the drawings.

552.03.4 Forms. Construct forms so their removal does not damage the concrete.

Remove all forms and form members not designated to remain in place.

The term "exposed surfaces" means those concrete surfaces that are above the finished ground line.

Use metal or plywood forms for exposed surfaces, and countersink all bolt and rivet holes. Assure the forms are mortar-tight providing a smooth finished concrete surface meeting the specified shape. Rough lumber, tongue-and-groove lumber, and steel-framed wooden panel forms may be used for surfaces not exposed in the finished structure that do not adversely affect the strength or appearance of the finished structure.

Use only one type of material in any form or group of forms for exposed concrete surfaces on similar parts of a structure.

Use filleted forms for re-entrant angles. Chamfer forms 3/4- inch (20 mm) for all exposed corners and edges with an enclosed angle of less than 120°.

Design the forms and falsework assuming the concrete has a liquid weight of 150 pounds per cubic foot (2432 kg per m^3) minimum for vertical loads and 85 pounds per cubic foot (1378 kg per m^3) minimum for horizontal pressure. Include in the design allowances for temporary construction loads.

Do not place concrete exceeding the designed form pressure.

Use forms for completed structures that are removable without disturbing adjacent forms.

Form marks must conform to the general lines of the structure. Column form marks may be horizontal or vertical or both, being as symmetrical as practical.

Provide form openings that permit ready access for form cleanout, inspection, placement, and compaction of the concrete. Provide cleanout ports at the top surface of the concrete where placing is stopped in narrow forms for walls or columns or where the bottom of the form is inaccessible.

Remove all extraneous material within the forms before placing concrete.

Treat the forms interior surfaces to prevent mortar adhesion.

Water soak wooden forms to close shrinkage cracks.

Set and maintain forms to the specified alignment, grade, and section and leave in place after concrete is placed for the specified time in Subsection 552.03.11.

Form defects are cause to stop work until corrected.

Fit metal tie rods or anchorages within the forms with cones or other devices that permit the rod and anchorage to be removed to 1-inch (25 mm) below the surface without damaging the concrete.

Use metal tie fittings that leave the smallest possible size cavities. Dry pack cavities with cement mortar to produce a sound, smooth, even finished surface closely matching that of the adjacent concrete after form removal.

Use deck slab forms that permit vertical adjustment of the bottom of the slab form.

552.03.5 Placing Concrete.

A. General. Place concrete within the specified time limits in Section 551.03.4

Use an approved set-retarding admixture when ambient temperatures are expected to exceed 60 °F (15 °C) during deck slab concrete placement. Cement content reduction is not allowed.

Maintain the concrete temperature immediately before placement between 40 °F (5 °C) and 90 °F (32 °C).

Prevent concrete segregation and displacement of the reinforcement as the concrete is placed. Thoroughly clean all chutes, troughs, and pipes

with water after each run. Discharge flushing water away from the forms and in place concrete.

Use metal or metal-lined troughs and chutes that extend to the point of deposit. Use a hopper or other device to regulate the discharge.

Do not allow concrete to drop from a height exceeding 5 feet (1500 mm) unless its within a conduit.

Support bars to maintain their position as shown in the Contract.

Deposit concrete in small quantities at many points and then work or run it along the forms. Carefully fill each part of the forms, depositing the concrete as close as possible to its final position, working the coarse aggregates back from the face and forcing the concrete under and around the reinforcing bars. Do not allow concrete to fall through or over reinforcing steel, tie rods, or similar items.

Deposit concrete around steel shapes and closely spaced reinforcing bars, on one side of the steel, uniformly working it until the concrete flushes under the steel to the opposite side before any concrete is placed on the opposite side or over the steel.

Once the concrete has taken initial set, avoid jarring the forms or straining the projecting reinforcement ends.

Thoroughly consolidate all concrete, except seal concrete, during and immediately after depositing using mechanical vibration as follows:

1. Apply the vibration internally unless otherwise approved or as provided herein.
2. Vibrate the concrete at a minimum 4500 impulses per minute or as recommended by the vibrator manufacturer.
3. The vibration must visibly affect the concrete mass producing a 1-inch (25 mm) slump over a minimum 18-inch (460 mm) radius.
4. Use enough vibrators to compact each batch immediately after its placed.
5. Vibrate the concrete around the reinforcement and imbedded fixtures and into the form corners and angles.

   Vibrate at the point of deposit in areas of freshly deposited concrete. Slowly insert and remove the vibrators from the concrete. Vibrate to thoroughly consolidate the concrete without causing segregation or forming localized grout areas.

   Vibrate at uniformly spaced points and no farther apart than twice the radius over which the vibration is visible.
6. Do not apply vibration directly to or through the reinforcement or to non-plastic sections or layers of concrete. Do not use vibrators to transport concrete in the forms.
7. Supplement vibration by spading and tamping to produce smooth surfaces and dense concrete along form surfaces, in corners and locations impractical to reach with the vibrators.
8. These requirements apply to precast piling, concrete cribbing, and other precast members unless the manufacturer's vibration methods are approved.

   Place and secure all reinforcing, dowels, and other embedded items as specified before placing the concrete. Clean rust, scale, oil,

dried mortar deposits or foreign material from all embedded materials before embedding in the fresh concrete.

Continuously place concrete in each section of the work in horizontal layers, working continuously if necessary, to prevent stoppage planes.

Place the concrete in layers to thoroughly consolidate them with the concrete beneath. Place the succeeding layer before the previous layer has reached initial set.

Compact each layer to prevent separation planes between the preceding layer and the layer being placed.

The Project Manager may require an emergency bulkhead if concrete placement in a section is delayed longer than 20 minutes.

A construction joint is any place where concrete placement has stopped and the concrete has taken initial set. Make construction joints meeting Subsection 552.03.7 requirements.

Inset construction joints where a "feather edge" might be produced in the succeeding layer. Provide a minimum thickness of 6-inches (155 mm) in all succeeding layers.

Place concrete so all construction joints are across low shear stress regions and out of view to the greatest extent possible.

B. Pumping Concrete. Use pumping equipment having the capacity required for the work and able to produce a continuous stream of concrete free of air pockets. Locate the pump to prevent vibration damage to fresh placed concrete.

Once pumping is completed, remove concrete in the pipeline to be used in the work without causing contamination or separation.

Use concrete pump discharge lines of at least a 4-inch (105 mm) diameter.

Do not permit aluminum pipe or pumping equipment with aluminum parts to contact the concrete.

C. Concrete Columns. Place concrete in one continuous operation, unless otherwise specified.

Allow columns to set at least 12 hours before placing the caps.

Place concrete in the superstructure after the column forms have been stripped and the column is inspected by the Project Manager.

The superstructure load may be placed on the columns when the column concrete reaches 80 percent of the required 28-day compressive strength, determined by testing standard 6 by 12-inch (152 X 305 mm) test cylinders.

D. Concrete Piling. Furnish concrete piling meeting Section 559 requirements.

E. Concrete Slab and Girder Spans. Place slabs and girders having spans less than 30 feet (9145 mm) in one continuous operation.

Concrete slabs with girders spanning 30 feet (9145 mm) or more may be placed in two operations, first placing the girder stems to the bottom of the slab haunches, and then placing the slab.

Use shear keys made of beveled timber blocks inserted at least 1 ½-inches (40 mm) in the fresh concrete at the top of each girder stem. Place

the blocks to uniformly cover about one-half of the girder stem top surface. Remove the blocks when the concrete has set enough to retain its shape.

Do not place the slab until the girders have been in place for at least 24 hours.

Check all falsework for shrinkage, settlement, and tighten all wedges to insure minimum deflection of the stems caused by the slab weight before placing the slab.

Place concrete in girder haunches less than 3 feet (900 mm) high at the same time as the girder stem.

When any haunch or filler has a vertical height of 3 feet (900 mm) or more, place the abutment or columns, the haunch, and the girder in 3 successive stages: first, up to the lower side of the haunch; second, to the lower side of the girder; and third, to completion.

F. Concrete Slip-forming. Concrete barrier rails on bridges may be slip-formed.

Hand finish the traffic face and top of the barrier to remove air holes and other blemishes, followed by a light broomed finish.

Sections with concrete slumps or bulges causing barrier rail misalignment or inadequate concrete cover for reinforcing steel will be rejected.

552.03.6 Depositing Concrete Underwater. Use Class "AS" or "DS" concrete for seals specified in the Contract.

All costs for concrete placed outside of the plan dimensions and any change in the seal mix design for the Contractor's convenience is at Contractor expense.

Do not place concrete underwater without Project Manager approval.

When it is impractical or inadvisable to de-water an excavation before placing concrete, place a seal course underwater to seal the cofferdam. Place the entire seal in one continuous operation, meeting the following requirements:

Use a tremie system; or pump directly into a tremie hopper; or pump directly to the deposit point.

Use tremie systems made of rigid, watertight steel tube having a minimum diameter of 10-inches (255 mm) with a hopper at the top. Keep the tremies discharge end submerged in the deposited concrete, and the tremie tube full to the hopper bottom at all times during the concrete placement. When a load is dumped into the hopper, raise the tremie to start the flow of concrete until the load discharges to the hopper bottom. Use a tremie support that allows free movement of the discharge end and permits rapid lowering of the tremie to retard or stop the flow.

Pump seal concrete meeting Subsection 552.03.5(B) requirements.

Have a backup concrete pump or tremie available at the site to insure uninterrupted placing of the entire foundation seal.

Pump concrete into a tremie meeting the placing requirements for tremie-placed concrete.

When concrete is pumped directly, the discharge tube must be a rigid pipe extending at least 5 feet (1520 mm) above the water level during placement. The discharge line from the top of the rigid pipe to the concrete pump may be flexible.

Prevent water from entering the tube while placing concrete. Fill the tubes without washing the concrete.

Place concrete in a compact mass without disturbing it once deposited.

Do not place concrete in running water or expose it to the action of water before it has reached final set. Keep water still at the point of deposit.

Do not pump from the cofferdam while depositing concrete underwater.

Make all formwork retaining concrete underwater practically watertight.

Deposit concrete to produce horizontal surfaces.

After the seal concrete has cured and can withstand the hydrostatic pressure, de-water the cofferdam and place the remaining concrete in the dry.

Prepare the top surface of the foundation seal under Subsection 552.03.7 before joining fresh concrete to the seal concrete. Remove high spots to provide the clearances for reinforcing steel or projection of embedded piling.

552.03.7 Construction Joints. Obtain the Project Managers approval for construction joint locations.

If the concrete develops initial set due to placement delays, the stopping point is considered a construction joint.

Place concrete continuously from joint to joint. Make the joints perpendicular to the principal lines of stress and locate them at points of minimum shear.

Place a gauge strip, at least 2-inches (50 mm) thick, at all horizontal construction joints and at other directed locations inside the forms along all exposed faces to provide a straight line for the joints.

Before placing fresh concrete against set concrete, draw the forms tightly against the set concrete face and remove all gage strips and key forms. Remove all latence, loose and foreign materials from the surface by sandblasting, high-pressure water cutting, or light bushhammering. Keep the surface moist until resuming concrete placement. Apply a thin coat of neat cement to the surface or coat as specified just before resuming concrete placement.

Bond the successive courses by keying or doweling, as shown in the Contract, at the top layer of each day's work and at other points where work is interrupted.

552.03.8 Joints For Bridge Approach Slabs. Construct and seal joints between concrete approach slabs and structures or concrete pavement as specified.

Use forms for joints that are removable without damaging the concrete.

Protect the joint from damage and prevent debris and foreign material from entering the joint before installing the seal.

Limit construction equipment and other vehicles operated directly across the joint to rubber-tired equipment, unless approved joint protection is used.

Repair all spalls, fractures, breaks, or voids in the concrete joint surfaces as approved.

Before placing the seal, clean the joints by abrasive blast or other similar methods, followed with high-pressure air jets to remove all residue and foreign material. Protect expansion joint filler from the blast.

Make joint surfaces surface-dry when placing the seal.

552.03.9 Cold Weather Concreting.

A. General. Assume all risk for placing concrete during cold weather. Replace frozen or damaged concrete at Contractor expense.

Cold weather is anytime the ambient temperature is expected to drop below +35 °F (1 °C).

Remove ice, snow, and frost from the forms and reinforcing bars before placing concrete. Do not place concrete on frozen ground.

B. Heating Fresh Concrete. Assure the temperature of fresh concrete is between +60 °F (15 °C) and +90 °F (32 °C) when placed.

Aggregates may be heated by steam or dry heat. Direct flame heating is prohibited. Eliminate frozen lumps, ice, and snow.

Do not add salt or chemical admixtures to the concrete to prevent freezing.

C. Protection of Concrete.

1. **General.** Maintain the air temperature surrounding fresh concrete at a minimum +60 °F (15 °C) for 7 days after placement or at a minimum +70 °F (20 °C) for 72 hours followed by +40 °F (5 °C) minimum for 96 hours. Place enclosures and heating equipment to maintain these temperatures before placing concrete.
2. **Deck Slabs and Barriers.** Protect and cure deck slabs and barriers placed after October 15 and before the following May 15 until the standard field-cured cylinders reach 90 percent of the specified minimum required strength.

   Maintain air temperatures surrounding the barriers and slabs between +50 °F (10 °C) and 120 °F (50 °C) during the cure period. Fully enclose the slabs and barriers on the tops, bottoms, and sides with space between the enclosures and the slabs and forms. Apply external heat as required to maintain the specified temperature within the enclosure.

   Insulated coverings placed directly on surfaces are not an acceptable substitute for the enclosure.

   Furnish and place recording thermometers at the locations designated by the Project Manager.
3. **Concrete Cured Under Water.** Substructure units other than those supported by falsework may be cured by a combination of heating and flooding. Maintain the air surrounding the concrete at between +60 °F (15 °C) and +120 °F (50 °C) for 72 hours after concrete placement. The unit may then be flooded with water for the remainder of the 7 day cure period if the water temperature exceeds +35 °F (2 °C). Maintain the air temperature surrounding any portion of the concrete remaining above water at +40 °F (5 °C) for the remainder of the 7 day period.

   Footings may be cured by flooding with at least 12-inches (305 mm) of water over the footing top if the water temperature stays at or above 35 °F (2 °C). Continue curing for 10 days after placement. Cure seals under water for at least 3 days before de-watering.

D. End of Curing Period. Lower the temperature within enclosures not to exceed 15 °F (10 °C) per hour until the inside and outside air temperatures are equal.

E. **Heating Equipment.** Block combustion heaters up off the concrete surface and vent them outside the enclosure. Assure heating equipment uniformly distributes heat around the concrete with the air temperature at the concrete surface never exceeding +120 °F (50 °C).

F. **Field-Cured Cylinders.** Determine the number of field-cured test cylinders, to include a minimum 6 per each days placement. Cast field-cured cylinders in single-use 6 x 12-inch (152 X 305 mm) round molds under MT-101. Protect the cylinders from moisture loss in the same manner used for the slab. Place the cylinders at the locations designated by the Project Manager and expose them to the same conditions as the slab until they are removed for testing.

Test field-cured cylinders within 36 hours after removal and not less than 5 days after casting under AASHTO T-22, except that the moist cure period is omitted. Perform tests using a certified testing laboratory. Furnish the Project Manager certified copies of the test results.

The Department may witness selected tests and testing procedures.

Two cylinders constitute a test with the test value being the average of the two compressive strengths. Continue curing and protection until the tests indicate the specified compressive strength is reached.

G. **Recording Thermometers.** Use recording thermometers that are automatic, continuous chart recording type. The range must be from +32 °F (0 °C) to at least +150 °F (65 °C) for conventional cure and +212° F (100 °C) for steam cure. Each chart must cover a minimum of 24 hours and 7 days maximum. Record only one cure period on each chart. Give the charts to the Project Manager at the end of each cure period.

Calibrate recording thermometers to the Project Manager's standard thermometer before each use and as directed.

Furnish thermometers, charts, calibration thermometers, and other equipment to maintain the thermometers.

552.03.10 Curing Concrete. Cure concrete under Subsection 551.03.6 and the applicable requirements of Subsection 552.03.9.

552.03.11 Removal of Forms and Falsework. Do not release, loosen, or remove forms or falsework without the Project Manager's approval. This approval does not relieve the Contractor of responsibility for the safety of work.

Approval to remove forms will be given when the minimum times in Table 552-1 have elapsed after placing the concrete.

The times in Table 552-1 are exclusive of days when the ambient temperature falls below 40 °F (5 °C); as the 7 day curing period is based on a minimum curing temperature of 60 °F (15 °C).

The exact time lapse before forms may be removed will be determined by the Project Manager based on the site curing conditions of the concrete.

The Contractor may request, in writing, to use high early strength cement or a richer mix to reach concrete compressive strengths earlier than the schedule shown in Table 552-1.

TABLE 552-1
MINIMUM CURE TIMES BEFORE FORM REMOVAL

ITEM	MINIMUM TIME
Walls, piers, and abutments (not yet supporting loads)	12 hours
Sides of columns, beams, and other comparable parts	12 hours
Railings (support forms)	3 days
Sidewalks on bridges	7 days
Slabs when supported on steel or wood stringers and precast concrete girders with unsupported span lengths less than 10 feet (3048 mm)	7 days
Centering under crossbeams, girders, T-beams, caps, struts, box girders, top slabs on concrete box culverts, and slabs	14 days or 80% percent of the specified 28-day strength

Remove all forms, blocks and bracing. Remove mortar lips and all irregularities caused by form joints.

The presence of honeycombed areas may cause rejection of the work, and upon written notice, require removal and rebuilding of the work in whole or part at Contractor expense.

After the forms are removed, cut back and repair all projecting wires, tie bolts, and other metal form ties passing through the concrete meeting Subsection 552.03.4 requirements.

Repair honeycombed concrete in all parts of the work and voids and depressions in exposed portions of the work as follows:

1. Chip back all coarse and broken material to a dense, uniform concrete surface with exposed solid coarse aggregate;
2. Cut back feather edges to form faces perpendicular to the surface being patched;
3. Saturate all cavity surfaces with water, and apply a thin layer of neat cement;
4. Fill the cavity with a thick mortar mixed in the same proportions as the concrete used in the work and at the same temperature as the surface against which the mortar is placed.

Use a blend of portland cement, white portland cement and sand, proportioned to match the color of the concrete being repaired. Tamp the mortar into place, and float the surface using a wooden float before initial set takes place. Cure the patch under Subsection 551.03.6.

For patching large or deep areas, add coarse aggregate to the patching material to provide a dense, well-bonded, and cured patch.

Pull or remove all falsework piling 1 foot (305 mm) below the finished ground line or streambed unless otherwise specified.

552.03.12 Finishing Concrete. Finish all exposed vertical concrete surfaces to meet the Ordinary Finish requirements in Subsection 552.03.12(A).

Finish concrete bridge deck slabs and concrete curb and sidewalk surfaces to meet the requirements of Subsections 552.03.12(E) and © respectively.

A. Ordinary Finish. An Ordinary Finish is the concrete surface left once the forms are removed and all holes caused by form ties, trapped air, and all other defects are repaired. The finished surface must be true and even, free from stone pockets, depressions, or projections beyond the surface.

Ordinary Finish is produced as follows:

1. Soak the concrete surface with water, and use the patching mortar specified in Subsection 552.03.11, working it into the small air holes and other voids in the concrete face with a sponge float or wooden float;
2. Rub off excess mortar after the mortar is partially set using burlap or carpet;
3. Remove uneven mortar surfaces that have set too hard by rubbing the entire surface with a carborundum stone and water;
4. Produce a finished surface that is uniform in texture and color.

Rub finish all surfaces not repairable by the Ordinary Finish method meeting Subsection 552.03.12(B).

The Ordinary Finish may not be required for exposed vertical concrete surfaces listed below, if the forming produces a true and uniform surface and minor defects are repaired as specified:

1. Interior surfaces of box type concrete structures such as culverts, stockpasses, and minor grade separations;
2. Concrete diaphragms for prestress girders;
3. Pier shafts, abutment walls, columns, struts, crossbeams, or other substructure components located where they are not readily subject to public access or view. In general, substructure elements on bridges in undeveloped rural areas and more than 25 feet (7620 mm) from the edge of the public road, located in or over streams not used extensively for recreation, or exclusively over railway property are not considered subject to public access and view.

Good forming practice is considered as:

1. Using materials with a smooth surface free from holes, tears, dents, and gouges;
2. Using the largest practical pieces to minimize joints;
3. Arranging joints to be vertically or horizontally symmetrical;
4. Using bracing to prevent bulges, offsets, and other major defects in the concrete surface.

Repair major surface defects, and finish the substructure unit surface or other structural components to a uniform appearance.

Major surface defects are large rock pockets, offsets at form joints exceeding 1/4-inch (6 mm), bulges, projections and depressions that deviate from the surface plane by more than 1/4-inch (6 mm) in any 4 foot (1219 mm) length, and all other defects that reduce plan reinforcing bar cover by more than 1/4-inch (6 mm).

Minor surface defects may be corrected without finishing the surrounding surface. Remove mortar fins even with the surrounding surface. Fill air holes exceeding 3/4-inch (20 mm) in the longest dimension

with mortar and strike off even with the surrounding surface. Patch minor rock pockets, tie holes, and the like as specified in Subsection 552.03.11.

B. Rubbed Finish. After concrete has hardened, saturate the surface with water and rub using a medium-coarse carborundum stone with a small quantity of mortar on its face. Approved bonding agents may be used.

Use mortar consisting of cement and fine sand in the same proportions used in the concrete being rubbed.

When forms are removed while the concrete is "green", wet the surface and rub it with a wooden float. If approved the thin mortar described above may be used for rubbing.

Continue rubbing until all form marks, projections, and irregularities are removed, all voids filled, and a uniform surface is obtained. Keep the paste produced by rubbing moist and allow it to set for at least 5 days. Smooth the surface by rubbing with a fine carborundum stone and water. Rub to produce a smooth texture and uniform color over the entire surface. After the final rubbing is complete and the surface has dried, rub the entire surface with burlap to remove loose mortar. The finished surface cannot have unsound patches, paste, powder, or objectionable marks.

C. Broomed Finish for Curbs and Sidewalks. Finish the surface of concrete curbs and sidewalks to the lines and grades in the Contract. Work the concrete until the coarse aggregate is forced into the body of the concrete and no coarse aggregate is exposed. Float the surface with a wooden float producing a smooth and uniform surface.

Apply a broom finish to curbs or sidewalks. Make the strokes square across the curb or sidewalk from edge to edge with adjacent strokes overlapped. Do not tear the concrete surface when applying the finish. Produce regular corrugations a maximum 1/8-inch (3 mm) deep.

D. Special Tooled Finish. Produce special tooled finishes using a bushhammer, a pick, a crandall, or other approved tool. Use air tools unless otherwise directed. Do not begin tooling until the concrete has set for at least 7 days, or longer if necessary, to prevent "picking" the aggregate out of the surface. Produce a finished surface showing broken aggregate in a matrix of mortar, each aggregate particle being in slight relief.

E. Concrete Bridge Decks. Finish deck slabs by the machine method, excluding small or irregularly shaped areas where a machine is impractical.

1. **Machine Method.** Use a self-propelled transverse finishing machine to strike off and finish the surface of deck-slab concrete. Furnish the Project Manager information on the location and method of rail support, size of rail members, and a description of the machine.

   Trial run the finishing machine over the entire deck area to be finished before placing any concrete. Make the trial run with the machine and rails set to the specified grade and section. Attach a spacer to the bottom of the strike-off 1/8-inch (3 mm) in thickness less than the concrete cover shown in the Contract. Adjust the support rails to compensate for dead-load deflections in the bridge girders. Adjust transverse strike-off support rails to match any changes in the deck section. Make transverse rail adjustments to maintain the specified surface tolerances. Record trial run transverse rail adjustments for use

during the deck finishing operations. Make all adjustments to maintain proper grade, section, concrete cover over slab reinforcement, and slab thickness before any concrete is placed.

While placing the concrete, make enough strike-off passes to produce the required profile and section.

Maintain the heading of concrete placement nearly parallel to and not more than 10 feet (3 m) ahead of the strike-off. The concrete carried ahead of the strike-off must not cause wheel slippage or other unsatisfactory operation.

Orient the transverse axis of the finishing machine parallel to centerline of bearing on all pre-stress and steel girder spans skewed more than 15 degrees. Make the concrete placement heading parallel to the strike-off heading to produce equal loads on each girder.

2. **Hand Finishing.** Obtain the Project Manager's approval for hand finishing on deck slabs.

   Strike off concrete using a template or vibrating screed and finish to a smooth, even surface meeting the required profile and section using longitudinal and transverse floating. Power trowels are not allowed.

3. **Straight-edging.** Test the plastic concrete surface for surface smoothness behind the finishing machine with a 10 foot (3 m) straightedge. Assure the straightedge contacts the surface in successive positions parallel to the centerline of roadway across the entire slab width. Make longitudinal advances in maximum 5 foot (1524 mm) increments.

   Immediately fill depressions with fresh concrete, consolidate, strike off, and finish. Remove high areas with a 10 foot (3 m) cutting straightedge and refinish. Correct all other surface defects using a 10 foot (3 m) float or combination float and cutting straightedge.

   Provide footbridge(s) that clear span the fresh concrete for complete finishing, texturing, curing, straightedge testing, and surface correction.

   Continue straightedge testing and surface correction until the entire surface meets the specified surface-smoothness requirements.

   Limited hand floating may be used to correct defects left by the finishing machine. Hand floating is not required if the machine-finished surface meets surface-smoothness requirements and is free of defects.

4. **Bridge Deck Surface Texture.** Texture the bridge deck surface with transverse grooves while the concrete is plastic. Use a hand or mechanically-operated comb or broom having a single row of steel tines spaced 3/4-inch (20 mm) center-to-center. Use tines of approximately 0.03 inch (1 mm) thick, 0.08 inch wide (2 mm), and from 4 to 6-inches long (105 to 155 mm).

   Operate the handheld texturing device from a footbridge. Make the application, the angle of tines with the surface, and the pressure on the concrete to produce a groove depth of between 1/8 to 3/16-inch (3 to 5 mm) without the grooves flowing together, tearing the surface, or displacing the coarse aggregate.

Do not overlap successive passes of the texturing device.

Terminate grooves 1 foot (305 mm) from the face of any curb or barrier. Skewed bridge decks may be textured parallel to the heading of concrete strike-off and finishing.

The allowable surface smoothness variation is independent of the grooves formed by the transverse texturing.

5. **Broom Texture.** Hand finish the traffic surface of curbs, sidewalks, and other horizontal surfaces to receive a broom finish under Subsection 552.03.12(E)(2). Manipulate the broom to produce a smooth, sealed surface meeting the specified surface-smoothness requirements.

   The texturing broom may be any medium-stiff bristled broom. Broom at right angles to the curb face or sidewalk and produce a uniform close spaced texture not exceeding ⅛" (3 mm) deep.

6. **Surface Smoothness.** The finished surface must not vary more than 1/8-inch (3 mm) from a 10 foot (3 m) straightedge placed parallel to the roadway centerline.

   High spots are measured as one-half the distance between the end of the straightedge and the pavement surface with the straightedge centered on the apex and the opposite end held in contact with the surface. Low spot variations are measured as the distance from the straightedge to the surface with the straightedge centered on the low point. Correct unacceptable surface variations by grinding off high spots and patching or filling low areas.

   Subsequent surface-sealing will not be required where the grooved surface is produced using a diamond-faced saw-type cutter for grinding.

   Perform surface sealing as follows for areas ground using conventional star-wheel-type cutters:

   Seal all areas where removal exceeds 1/4-inch (6 mm) in depth with an approved, concrete-colored, low-viscosity epoxy-resin adhesive. Produce a non-skid texture using a steel-tine broom or by applying medium-coarse silica sand to the plastic epoxy surface. Meet the surface smoothness requirements.

7. **Protective, Remedial, and Corrective Work on Deck Slab Concrete.** Do not place concrete for deck slabs and stop work when rain appears imminent. Take immediate action to strike off all concrete in place to promote drainage and prevent ponding.

   Placing or finishing work that manipulates the concrete will not be allowed during precipitation.

   Deck slabs areas where precipitation has been incorporated into the concrete may be rejected. Make a maximum 3 light passes with a straightedge float to remove excess water after the precipitation stops.

   Protective work is that work necessary to protect unhardened concrete from damage by hail and rain. This includes covering the concrete with a protective covering when conditions warrant.

   Remedial work is that work to restore a surface profile and texture on unhardened, rain-damaged concrete. Concrete damaged by rain to the extent the texture is obliterated and has a sandy appearance may

be repaired by removing excess water and restoring it to the specified surface smoothness and texture.

Hardened concrete is concrete that is non-plastic and does not allow the vibrator to penetrate under its own weight.

Corrective work is work to provide an acceptable profile and texture on hardened, rain-damaged concrete.

Do not place fresh concrete against hardened concrete until a construction joint is placed under Subsection 552.03.7.

Correct areas exceeding the specified surface-smoothness tolerance and areas where the specified texture cannot be produced by grinding and grooving using concrete grinding machines.

Use a diamond saw type grooving machine.

Grooves may be either longitudinal or transverse. Space grooves at 3/4-inch (20 mm) centers and be 1/8-inch (3 mm) wide by 1/8 to 3/16-inch deep (3 to 5 mm).

Grooving is not required on areas that measure 10 feet (3000 mm) or less in length parallel to centerline of roadway.

Do not grind or groove so that concrete cover is reduced over the top reinforcing bars to less than 2-inches (50 mm).

Remove, replace, or overlay areas that cannot be corrected to the required surface smoothness and texture by grinding and grooving. Submit proposed overlay methods in writing to the Project Manager for approval before use.

Remove all latence and hardened, excess concrete from construction joints before placing curbs, barriers, or other concrete.

Furnish all protective, remedial, and corrective work to provide an approved deck slab at Contractor expense.

F. Bridge Seats and Tops of Walls. Bring the concrete at bridge seats and tops of walls up to the required grade elevation, strike off with a straightedge, and float to a smooth, uniform texture.

Slope the concrete surfaces in areas of bridge bearing assemblies to drain water away from the bearing devices as specified.

Bushhammering is permitted only for leveling the concrete surface under the bearing plate and removing latence and loose and foreign material. Bushhammer to produce full, level bearing.

Use steel shims when necessary to bring the masonry plates up to grade. Use shims of the same size as the masonry plate and a minimum 1/4-inch (6 mm) thick. When elastomeric bearing pads are used, perform the beam seat treatment specified in Subsection 556.03.19 using steel shims of the same size as the sole plate except for thickness. Place the shims between the sole plate and the elastomeric pad.

552.03.13 Installation of Expansion and Contraction Joints. Construct expansion and contraction joints meeting the Contract requirements.

A. Open Joints. Construct open joints by inserting and removing a template made of wood, metal, or other approved material. Remove the template without chipping or breaking the concrete corners.

Do not extend reinforcement across an open joint unless specified.

B. Filled Joints. Construct poured expansion joints similar to open joints.

When pre-molded expansion joints are specified, the thickness of installed filler is specified in the Contract. Match the joint filler to the shape and size of the surfaces to be joined and fix it firmly against the existing surface. Do not displace the joint filler while placing concrete.

Where more than one piece of filler is used to cover any joint surface, place the abutting pieces in close contact and join them together with a layer of asphalt-saturated roofing felt. Use a minimum 20 pound (1 kg per m^2) grade roofing felt having one side covered with hot asphalt.

The filled joints will be inspected immediately after the forms are removed. Neatly cut and remove all concrete or mortar that has sealed across the joint. Fill openings in deck slab joints during construction with an approved tar or asphalt as directed.

Place the necessary dowels, load-transfer devices, and other devices as specified.

C. Steel Joints. Fabricate and paint the joints as specified. Assure that the surface in the finished plane is true and free of warping.

Hold joints in the correct position during concrete placement.

Use the openings at expansion joints shown in the Contract, correcting for installation temperature. Maintain the required clearance.

D. Water Stops. Place water stops as specified.

552.03.14 Placing Anchor Bolts. Anchor bolt holes may be drilled or formed.

Form bolt holes by inserting treated wood plugs or metal pipe sleeves into the plastic concrete and withdrawing the devices after the concrete has partially set. Form bolt holes at least 3-inches (75 mm) in diameter to allow for horizontal adjustment.

Drill holes at least 1-inch (25 mm) larger than the diameter of the anchor bolts. Verify hole size before setting the beams.

Assure all anchor bolts for shoe assemblies project above the plane of the substructure concrete to assure full anchor bolt and nut engagement after the final placement of the shoe assemblies.

Fill holes two-thirds full with an approved non-shrink or epoxy grout. Force the bolts down using uniform, even pressure or light blows with a hammer until the grout rises to the top of each hole and the anchor bolt nut rests firmly against the metal shoe or pedestal.

Determine the final anchor bolt locations, making allowance for thermal effects on the superstructure at the time of grouting.

Remove all excess grout, and clean the metal surfaces for painting.

Do not grout anchor bolts in freezing weather.

Make a written request to the use non-shrink or epoxy grout products formulated specifically for use at temperatures below freezing.

Protect bolt holes against damage from ice by filling with a non-evaporating antifreeze solution. Before grouting the bolts, remove the antifreeze and thoroughly flush the holes with clean water.

Anchor bolts for simple spans may be set to the exact location in fresh concrete. Correct all inaccuracies in bolt locations using approved methods at Contractor expense.

552.03.15 Setting Shoes and Bearing Plates. Set shoes and bearing plates under Subsections 556.03.19 and 552.03.12(F).

Place masonry bearing plates on fiber-reinforced pads, sized and positioned to project a minimum of 1/2-inch (15 mm) on all sides of the bearing plates.

552.03.16 Drainage Holes and Weep Holes. Construct drainage holes and weep holes as specified. Place ports and vents for equalizing hydrostatic pressure where required.

Forms for weep holes through concrete may be wood, clay pipe, PVC pipe, concrete drain pipe, wooden boxes, or metal. Remove wooden forms, if used, after the concrete is placed. Paint or galvanize exposed metal drain surfaces as specified.

552.03.17 Pipes, Conduits, and Ducts. Install and rigidly brace pipes, conduits, and ducts encased in concrete before the concrete is placed.

Furnish and install 3-inch (75 mm) length plastic, PVC pipe or approved equal in the bottom slab at the low point of each box girder cell to provide drainage for each cell. Extend the pipe 1/4-inch (6 mm) below the bottom of the slab and flush with the slab's top surface.

552.03.18 Loading of Piers and Abutments. Do not place any superstructure load on finished bents, piers, or abutments until approved. The minimum time before any superstructure load is placed on the substructure is 7 days, unless otherwise approved.

552.03.19 Opening to Traffic. Open concrete deck bridges to traffic only with the Project Manager's approval.

Do not open concrete bridge decks to traffic when the air temperature during the cure period is 50 °F (10 °C) or higher, until one of the following is met:

A. Twenty-one days after placing concrete unless standard strength test results indicate more time is required; or

B. Test results on field-cured test cylinders indicate that at least 90 percent of the required minimum strength has been attained. Two cylinders constitute a test, with the test strength being the average of the strengths of the two individual cylinders.

The Project Manager will determine the opening date when the ambient temperature during the cure period has been lower than 50 °F (10 °C).

552.03.20 Defective Work. Repair or replace all defective work at Contractor expense. Remove and replace the entire section at Contractor expense when the Project Manager determines the repair is not adequate.

552.04 METHOD OF MEASUREMENT. Concrete is measured in cubic yards (cubic meters) from the plan dimensions. Plan quantities will not be re-measured except as specified in Subsection 552.05.

Fillets, scoring's, and chamfers 2-inches (50 mm) or less in the greatest dimension are omitted from the quantity calculations.

No deductions are made for the concrete volume displaced by reinforcing steel, structural steel, prestressed beams, anchor bolts, drains, weep holes, joint fillers, conduits, or junction boxes.

Deductions are made for the concrete volume displaced by timber, steel, and concrete piles. The timber pile volume encased by concrete is assumed as 0.8 cubic foot per linear foot (0.74 m^3 per m) of pile.

When ordered in writing by the Project Manager, concrete quantities placed outside neat lines, are calculated and added for payment.

No measurement is made for forms, falsework, cofferdams, bracing, and the like.

552.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

A. The calculated quantities involved in changes ordered in writing by the Engineer are added or deducted from the Contract quantities.

B. A re-calculation will be made and the corrected quantity included for payment, in lieu of the Contract quantity, when the Contract quantity of any complete structure element is in error by five percent or more. A complete structure element is the smallest portion of a total structure for which a quantity is included in the Contract. The party to the Contract requesting an adjustment in quantity shall present to the other party three copies of the description and location and recalculated quantities of the structure element that has the quantity error.

C. Classes "AD", "DD", and "BD Modified" concrete placed in bridges are subject to a payment reduction based on lot payment factors under Subsection 551.03.7(C)(1).

Seal concrete, Class "AS" or "DS" is not under the lot payment factors.

The following percentages of the Contract quantity for a structure element are allowed for payment on progress estimates:

1. 40% of superstructure concrete when deck forms are complete in place;
2. 80% when all types of concrete are placed;
3. 85% when curing is complete;
4. 95% when all finishing is complete;
5. 100% when the structure element area is cleaned up to the Engineer's satisfaction.

Pay Item	Pay Unit
Concrete	Cubic Yard (cubic meter)

Payment at the contract unit price is full compensation for all necessary resources to complete the item of work under the Contract.

SECTION 553
PRESTRESSED CONCRETE MEMBERS

553.01 DESCRIPTION. This work is the furnishing and placing of precast, prestressed concrete beams, slabs, piling, and other structural members.

553.02 MATERIALS.

553.02.1 Concrete. Furnish concrete meeting Section 551 requirements.

553.02.2 Reinforcing Steel. Furnish reinforcing steel meeting Subsection 711.01.1 requirements. Obtain the Engineer's written approval for reinforcing steel substitutions.

State on the fabrication drawings showing reinforcing steel details the following or similar words: "All dimensions are out-to-out".

553.02.3 Steel Rods and Bolts. Furnish rods used as dowels made from ASTM A 307 steel and bolts meeting Subsection 711.07 requirements.

553.02.4 Prestress Steel. Furnish high tensile strength steel wire meeting Subsection 711.11 requirements.

Furnish the Project Manager one certified copy of the typical load-elongation curves for all shipments of prestress steel to the fabrication plant.

Assure all prestress steel used in the work is free of rust, corrosion, dirt, oil, spatter from welding or flame cutting, kinks, bends, nicks, broken wires, or other defects.

Prestress steel is sampled under MT-111.

553.02.5 Enclosures. Use metallic enclosures, excluding aluminum, or forms using removable cores or ducts made of rubber or other approved material. Remove cores and ducts before installing the prestress steel.

Use enclosures that are mortartight and maintain their shape when subjected to loading.

Use enclosures that are 1/4-inch (6 mm) larger in internal diameter than the bar, cable, strand, or group of wires being enclosed.

Equip cores or ducts with pipes or other connections for grout injection when pressure grouting is specified.

553.02.6 Structural Steel. Furnish structural steel meeting Subsection 711.02 requirements.

553.02.7 Elastomeric Bearing Devices. Furnish elastomeric bearing devices meeting Subsection 711.14 requirements.

553.03 CONSTRUCTION REQUIREMENTS.

553.03.1 Fabrication. Fabricate all prestress concrete members using a manufacturing plant currently certified by the Prestress Concrete Institute in the category applicable to the member being fabricated.

Furnish the Project Manager a copy of the plant's current certification in the applicable category along with the fabrication drawings for the elements to be fabricated.

The fabricator may prestress by pretension or post-tensioning the member, subject to the contract requirements.

Obtain the Project Manager's written approval before changing the prestressing details.

553.03.2 Fabrication Drawings. Before casting members, submit fabrication drawings to the Project Manager for approval. Show complete details of the method, materials, and equipment proposed for use in prestressing.

Include in the fabrication drawings the following information:

1. An erection layout of the members placed in the structure or structures with each prestress member assigned a production number. Mark each completed member with an assigned number;
2. A tentative fabrication schedule;
3. The proposed mix design, including admixtures;
4. The prestress steel manufacturer's name and the applicable specifications;
5. Details of the method and sequence of stressing including the numbered or lettered layout to be followed to stress the member. Show complete details of the proposed method for tensioning the draped strands. Include in the details gauge and elongation readings for initial, intermediate, and final tensioning, as well as the deflection sequence, where applicable;
6. Complete details, including anticipated camber, tensioning forces (initial and final), and required concrete strengths (transfer and 28-day);
7. A complete detensioning procedure for the castings;
8. Details of items to be incorporated into the beam, such as chairs, inserts, hold-downs, etc., listed by source, type, size or capacity, and supplier;
9. Show all items incidental to the beams, such as bearing plates, rocker assemblies, anchor bolts, etc., if supplied by the beam fabricator;
10. All information and data required for fabrication;
11. Show the tack welding procedure's;
12. Detail the use of all external weights or hold-downs if used. If weights are not required, note it on the fabrication drawings.

Show all changes from the prestressed details in the Contract.

Submit design calculations of the system and method of production prestressing. Submit calculations on standard 8½ by 11-inch (A4 paper) paper.

Check and approve the fabrication drawings and design calculations before submitting to the Project Manager. Show the Contractor's approval on the drawings.

Furnish 4 prints each of the fabrication drawings for approval. An additional 3 or more prints of the approved drawings may be requested.

Furnish all fabrication drawings on 22 x 36-inch (A1 paper) paper with a 1½-inch (38 mm) margin on the left side and ½-inch (13 mm) margins on the other 3 sides.

Do not begin fabrication until the drawings are Department approved and available at the plant.

553.03.3 Design of Concrete Mixtures. The prestressed girder concrete must have a minimum ultimate compressive strength of 4000 psi (27.6 MPa) at transfer of prestress and 5000 psi (34.5 MPa) at 28 days. The actual required strengths are specified in the Contract.

Furnish the Project Manager a concrete mix design that will produce concrete meeting the specified compressive strengths before use. Approved changes to the mix design may be permitted during fabrication.

Use a concrete design of between 6.5 to 8.0 sacks of cement per cubic yard (350 to 450 kg per m^3) of concrete.

Establish the Class "Pre" concrete slump range between 1-inch (25 mm) and 4 1/2-inches (115 mm). The high and low limits of the range cannot exceed 1 1/2-inches (38 mm). The range may be changed with the Engineer's approval.

553.03.4 Forms. Use steel side and bottom forms. End bulkhead forms may be steel or plywood.

Form joints and strand exits through bulkhead forms that are mortartight.

Check the grade and alignment of side forms before casting. Check the beam bed alignment for displacement while placing the concrete.

Construct beam bed forms to limit movement to not exceed 1/4-inch (6 mm) from a straight line in any 50 foot (15.25 m) length of the bed.

Use clean forms that are free from warp, bulge, and other defects.

Do not exceed a maximum offset of 1/16-inch (2 mm) where form sections are joined.

Treat the form facing with a bond breaker before each casting. Form treating materials that stain or react with concrete are not permitted. Apply form oil or other bond breaker materials without contaminating the prestress strand and reinforcing steel. Clean soiled strand or reinforcing with a non-contaminating solvent.

Chamfer all exposed concrete edges, excluding the beam top, with an enclosed angle less than 120 degrees. Use chamfer strips having no irregularities, and maintain smooth joints with the chamfer tightly fitted against abutting forms.

Fit forms with a grade strip or other positive control to establish the nominal depth of the beam.

Use forms that can be removed from the member without damaging the concrete.

Identify production form dimensions that vary from the Contract beam dimensions on the fabrication drawings.

553.03.5 Placing Reinforcing Steel. Place and secure all reinforcing steel as shown on the plans before placing concrete.

Fasten all bars at all intersections with adjacent bars.

Do not tack weld reinforcing steel if the reinforcing bar is a stress-carrying member. Welding non-stress reinforcing bars may be permitted with the Engineer's approval. Reinforcing steel welds not shown on the approved tacking detail or fabrication drawings are prohibited.

For convenience, additional reinforcing steel may be tied in for securing inserts, void ducts, etc., or may be secured by tack welding.

Protect the tensioning strand from weld spatter using wet burlap or other protective covering. Replace all strands with weld spatter at Contractor expense.

Provide the distance between the reinforcing and side forms using approved stays, ties, or chairs. Do not use precast mortar blocks, pebbles, pieces of broken stone or brick, metal pipe, or wooden blocks.

Provide clearance between the beam stirrups and the beam bed using metal chair supports with stainless steel or other approved, corrosion-resistant legs.

Use reinforcing steel in the ends of prestressed beams to provide clearance for the paving notch blockout, void ducts, embed plates and anchorages, and inserts without interfering with the reinforcement spacing.

Reinforcement in the prestressed member will be inspected in place and approved by the Inspector before the concrete is placed. Concrete placed before inspection may be rejected.

553.03.6 Prestressing Equipment. Use approved jacking equipment for prestressing.

Equip hydraulic jacks with pressure gauges. Have a certified testing laboratory calibrate each jack and gauge combination as a unit with the cylinder extension in the approximate position that it will be in at the final jacking force. Have a certified calibration chart for each jack.

Other types of jacks may be used with proving rings or other approved devices calibrated by a qualified testing laboratory.

Calibrate jacking equipment once each year and after each repair. Re-calibration may be required if any jack or gauge gives erratic results or if the difference between the gauge reading and elongations exceed allowable limits.

Equip tensioning systems with hydraulic gauges that prevent the gauge pointer from fluctuating until the jacking load is released from the tendon. The gauge must read loads directly in pounds (Newtons) or have a chart to convert the dial reading into pounds (Newtons). Assure the gauge readings are accurate to within plus or minus 2 percent.

Locate the gauges to provide the operator and Inspector a clear view of elongation measurements and gauge readings. Use gauge dials graduated in increments not exceeding 100 pounds (700 kPa) pressure. The gauge range or load cells must not use the lower 10% of the manufacturer's rated capacity in determining the jacking stress, unless calibration data establishes accuracy within the 2% requirement at the lower range.

Assure the end anchorages and prestressed member stressing blocks can maintain the required tension in all prestressed tendons until the concrete has been placed and reached transfer strength. Equip the end anchorages and stressing blocks to detect deflection while prestressing. Checks for deflection will be made by the Inspector.

Provide the equipment to determine concrete compressive strengths at the location the prestressed members are manufactured. The test equipment may be mechanical or hydraulic, capable of applying and measuring the required load. Error for loads within the loading range of the test equipment cannot exceed an error of plus or minus 1.5%. Have a certified calibration diagram covering the entire use range with the equipment at all times. The indicated load of the testing equipment

will not have to be corrected by calculation or by the calibration diagram to obtain values when the values are within the required variation of ±1.5 percent.

Certify the concrete strength testing equipment every 2 years; after each repair or adjustment of the equipment; when a non-portable machine has been moved; and whenever accuracy is in question.

553.03.7 Pretensioning. Hold the prestressing elements in position using jacks when stressing. Keep a record of the jacking force and the elongations.

Multiple units may be cast in a continuous line and stressed at one time. Leave a space between the ends of the units to permit cutting of the strands.

Furnish strand in coils, reel-less packs, or on reels. Stringing may be performed by pulling single or multiple strands. Pull to gradually relieve strand rotation on coil or reel-less packs.

Strand with gripped points are not permitted within the lengths to be stressed.

Bring all prestress tendons to the uniform initial tension on the approved fabrication drawings. Initial tension is the minimum force required to equalize stresses and eliminate slack in the strand. Submit alternate initial loading proposals to the Project Manager for approval.

The initial load may be applied by the jack used for single strand tensioning or by any other approved method that provides a definite, uniform load. Regardless of the method used, measure the initial load within plus or minus 100 pounds (450 N). Compute elongation measurements for initial tensioning but do not use as a measurement of the initial force.

Once initial tensioning is complete, reference mark the strand as directed. The mark must provide an accurate measurement of elongation by final tensioning.

Measure the induced stress by gauge and check it by elongation, load cell, or both. The results must agree within 5%. Do not permit jacking stress to exceed 75% of the specified minimum ultimate tensile strength of the prestressing steel. Measure the strand elongation to within 1% of the theoretical elongation or 1/8-inch (3 mm), whichever is smaller. If a discrepancy between measured elongations and gauge readings exceeds 5%, check and correct the entire operation before proceeding with the work.

All uplift devices, hold-down devices, and strand openings in end bulkheads must have rounded, smooth surfaces at all contact points with the strand.

Take gauge readings, elongation measurements, and make calculations for elongation and include allowances for operational losses for the tensioning system used. These allowances must include losses for strand slippage, anchor movement, friction, strand rotation, and other forces acting on the strand.

If the temperature difference between the strand at the time of tensioning and the concrete at the time of pouring exceeds 30 °F (16 °C), correct the computed elongation measurements for the temperature differences.

Provide copies of the elongation calculations to fabrication and inspection personnel at the beginning of production to insure all allowances for the method of tensioning have been considered.

553.03.8 Final Tensioning.

A. Single Strand Tensioning. After the initial load is applied and the reference marks are established, individually pull the strands to the final load. Tension each strand to the load required by the gauge reading.

The elongation measurement must be within plus or minus 5% of the load indicated by the gauge reading. If the load indicated by gauge reading doesn't agree with the measured elongation within the required tolerance, discontinue tensioning and inspect the bed for restrictions that could affect the accuracy of the applied load.

If the measurements agree, 3 more strands may be tensioned. If elongation measurement and gauge readings are within the required tolerance, the remaining strands may be tensioned.

As some variation in the modulus of elasticity and the cross-sectional area of a strand does exist, the strand tensioning may be accepted, if the difference between the load determined by elongation and that indicated by the gauge does not exceed 5%. A maximum 10% of the total number of straight strands for any one line of casting will be accepted on this basis.

If the difference between the elongation load and gauge readings exceed the limits, discontinue tensioning and correct the problem.

B. Multiple Strand Tensioning. Mark each strand, once pre-loaded and seated in the anchorage, at both end anchorages to determine elongation and slippage. The Inspector will establish references to verify parallel movement.

Measure the stressing force by the gauge system and check it by the elongation measurement.

Use two load cells to verify the applied design load and check the uniformity of pull. Place one load cell on each side of the line of pull, preferably on the outermost strands of an upper row of straight strands.

If the hydraulic gauge and the load cells agree with the elongation measurements within plus or minus 5%, the strands are acceptably tensioned. If the gauge reading is within 5% but either or both of the load cells exceed that limit, re-tension the strands including pre-loading. Locate and place the load cells on the strands nearest to those previously gauged.

If, upon re-tensioning, the load cells are within the 5% tolerance, no excess strand slippage has occurred, and the movable anchorage has traveled the required distance, the tensioning may be accepted.

If the difference between the gauge readings, load cell readings, and elongation measurements exceed the tolerance limit, stop tensioning and correct the problem.

Lubricate the jacking ram or rams, guide rods, and movable anchorage rails to minimize friction and run the ram through its length of travel at least 4 times before tensioning the strand.

C. Tensioning Draped Strands. Draped, pre-tensioned strands may be tensioned by partial jacking at the stressing block and subsequent depressing or uplifting to the deflected position or by tensioning to the initial and final loads with the tendons held in the final design position using pins, rollers, or other devices. Use low-friction devices at all points of slope change of the draped strand.

When draped strands are partially tensioned in the straight condition and then depressed to the final design position, determination of the final load is made as follows:

Before starting the tensioning operation, place a load cell at the dead end anchorage on one of the strands to be deflected in each line of beams. The Inspector will select the strand to which the load cell will be placed. Once tensioning is complete, the load cell reading must be within plus or minus 6% of the final design load.

Should the load cell reading exceed the allowable tolerance, use additional deflecting jacks to distribute friction and restraint at the deflection points or, if necessary, revise the entire method for applying the final design load within tolerances.

If the tensioning of draped strands indicates readings within the tolerances, the Inspector may require load cells for occasional checks.

If tensioning of the draped strands is performed by partial tensioning and uplift or, by tensioning in the draped position, submit the method for approval before use.

Strand splicing using approved devices is permitted. One splice is allowed on any one strand between anchorages. Splices must not fall within a beam. For single strand tensioning, the number of strands spliced is not restricted. When multiple strand tensioning is used, the number of strands spliced cannot not exceed 10% of the total number of strands in the casting line or all the strands must be spliced.

Use only one manufacturer's strand in any one tensioning operation.

Use the same direction of twist of strand wires in all spliced strands.

One wire failure in 7 wire strands may remain in the casting, subject to the following:

For beams with:

Less than 20 strands, no wire breaks permitted.
20 to 39 strands, 1 wire break permitted.
40 to 59 strands, 2 wire breaks permitted.
60 or more strands, 3 wire breaks permitted.

Should wire breaks exceed these limits, or more than 1 wire break in any individual strand, remove and replace that strand or strands.

Locate all wire breaks allowed to remain in the casting, and securely wrap the broken ends with tie wire to prevent unraveling.

The Fabricator may be ordered to check the prestressing steel in a tensioned member for loss of prestress before placing concrete. The Engineer will approve the checking method for loss of prestress. Re-tension all strands showing a loss of prestress exceeding 3% of the original computed jacking stress.

Except as permitted in Subsection 553.03.5, do not weld, flame-cut, or ground welding equipment to the bed or forms after the prestress strand has been tensioned.

553.03.9 Placing Concrete.

A. General. Batch and mix concrete under Subsection 551.03.3, except as provided below:

1. Provide master batch sheets to the Project Manager for review before production;
2. A timing device that locks the discharge gates of a stationary mixer is not required, however, the mixer must not be emptied until the materials have been mixed the specified time;
3. Ready-mix delivery slips are not required unless specifically requested.

The batching operation and equipment may be inspected at any time. The work will be stopped for failure to use approved procedures or equipment.

B. Method and Manner. Place concrete meeting Subsection 552.03.5 requirements and the following:

Obtain the Project Manager's approval before placing concrete in large members. Concrete may be placed in the member in a single lift if satisfactory results are obtained, or in multiple horizontal lifts provided cold joints are not formed. Remove and replace concrete containing cold joints. When concrete is placed in layers, place the first lift to fill the form slightly above the juncture of the bottom flange and the beam web.

Compact the concrete immediately after pouring with high-frequency mechanical vibrators operating at a minimum 4500 impulses per minute. Apply vibration internally, externally, or a combination of both methods to flush the mortar to the surface of the forms. Vibrate succeeding concrete layers to extend into the previously placed layer. Use vibrators to thoroughly consolidate the concrete to a plastic mass without causing segregation. Do not permit vibrator heads to contact reinforcing steel, prestressing steel, or other embedded items to aid consolidation. Slowly insert and remove internal vibrators from the concrete.

Have one additional vibrator available at the site at all times during concrete pours.

C. Concreting In Adverse Weather Conditions. Perform concrete work meeting Subsections 552.03.9(A) and (B) when the ambient air temperature falls below 40 °F (4 °C), except that the placement temperature for steam-cured Class "Pre" concrete must be between 50 °F (10 °C) and 90 °F (32 °C) at placement.

When the ambient temperature before concrete is placed is 35 °F (2 °C) or less, pre-heat forms to a minimum 50 °F (10 °C) removing all frost, snow, and ice from the forms and components to be embedded in the concrete.

Do not permit the concrete temperature to exceed 90 °F (32°C).

Cover open buckets of concrete with wet burlap mats or other approved coverings, when necessary, to prevent slump loss or premature drying.

553.03.10 Curing. Water-cure prestressed concrete members meeting Subsection 551.03.6(A) or steam-cure as specified below.

Protect water-cured concrete meeting Subsection 552.03.9© requirements.

Perform elevated-temperature steam process cure meeting the following requirements.

Completely enclose or cover casting beds for steam-cured members using curing blankets or other approved flexible coverings. Provide a minimum 6-inches (155 mm) of free air space between the enclosure or coverings and all concrete surfaces.

Secure flexible coverings to prevent moisture loss. Provide moisture before the cure cycle to aid hydration and prevent surface cracks caused by rapid water loss from the concrete.

Steam may be introduced before starting the cure cycle if the enclosure temperatures are maintained between 50 °F (10 °C) and 70 °F (21 °C). Fog-spray or cover the top surfaces of the members with wet blankets within 15 minutes after placing concrete to prevent moisture loss for a 3 hour period before the cure cycle.

Begin the steam-cure cycle after the concrete has been in place at least 3 hours. Maintain steam at 100 percent relative humidity, applied so it does not damage the surface of the concrete, forms, or tendons.

Raise the ambient temperature within the enclosures no faster than 40 °F (22 °C) per hour to a maximum temperature between 140 °F (60 °C) and 160 °F (71 °C). Maintain the temperature until the concrete has reached strength for transfer of prestress.

Once the cure cycle is complete, cool the beams by decreasing the temperature within the enclosures no faster than 40 °F (22 °C) per hour until the temperature difference between the inside and outside air is within 25 °F (14 °C), unless otherwise approved.

Keep a curing time-temperature record for each concrete pour in the casting bed. Provide one automatic temperature-recording thermometer for each 200 feet (61 m), or fraction thereof, of continuous bed length used. Record curing temperatures continuously for the full curing cycle. Place the temperature sensors at approved locations. Supplement automatic recording thermometers with standard bulb-type thermometers placed at approved locations. Certify the accuracy of automatic recorders once each year or when the recorder accuracy is in question. Steam curing is not permitted without automatic recorders.

The sideforms may be removed at the Contractor's discretion. Assume all responsibility removing forms before breaking the release cylinders. Concrete members damaged from early form removal will be rejected.

The cure cycle may be interrupted a maximum 20 minutes for form removal.

Do not expose members to below-freezing temperatures within 6 days of casting. In place of the 6 day requirement, the cure time may be based on the concrete strength. The concrete strength is determined by the average strengths of 3 standard 6 x 12-inch (152 X 305 mm) cylinders cast from different batches of concrete used in each round of beam castings. Expose these cylinders to the same cure and temperature conditions as the prestressed members. Immediately test the cylinders under AASHTO T22 without further curing, once removed from the cure area.

Curing may be discontinued if the average strengths of the 3 cylinders equals or exceeds the strengths specified in Subsection 551.03.7(C)(2). Should all cylinders fail, protect the member from freezing temperatures for the 6-day period. Cool all members as specified in this Subsection.

Cast compression cylinders for field tests of the 28-day strengths following MT-101. Cast the number of test cylinders as required in Subsection 551.03.7(A)(2) and MT-111.

The Contractor may submit in writing, alternate curing methods, for approval.

553.03.11 Transfer of Prestress. Prestressed strands may be released when the concrete has:

1. Reached the minimum compressive strength for transfer of prestress;
2. The cure cycle is complete;
3. Restrictive forms are remove.

If delays are anticipated, maintain the temperature in the curing enclosure at a minimum 50 °F (10 °C) until transfer of prestress.

Use positive, external hold-downs or weights to offset the uplifting forces in the member when the hold-down strands are released, when required.

Use a method of harped and straight strands release to hold the lateral eccentricity of prestress to a minimum. Detail the bed release and the strand-cutting pattern on the fabrication drawings. Changes to the release procedures shown on the approved drawings are not permitted except by written request and the Engineer's written approval.

Cast cylinders to determine prestressed transfer strengths using MT-101 and MT-111 as modified below:

> Cast and cure the release cylinders under the exact conditions the prestressed members were cured. The concrete sample for each cylinder will be selected at random from different batches.

Once the cure cycle is complete, test the release cylinders under AASHTO T 22. Test three cylinders to determine the prestressed transfer strengths for each round of beam castings. The average strengths of the three cylinders must equal or exceed **F'r + 0.35S.**

Where:

S = the standard deviation of the strengths for the three cylinders
F'r = the required concrete transfer strength as specified in the Contract

Test all 3 cylinders within 30 minutes.

Furnish the number of release cylinders required to perform these tests.

The Contractor may cast additional back-up test cylinders.

Should the release strengths not be reached and all back-up cylinders are broken, put the casting through at least one additional complete cure cycle. The Engineer may direct other tests to determine release strengths.

Test compression specimens using AASHTO T 22. While testing, apply the last one-half of the load at a rate between 1200 to 3000 psi (8.28 to 20.7 MPa) per minute.

The Inspector will witness the Fabricator's casting and testing of release cylinders.

553.03.12 Post-Tensioning. Begin tensioning of the prestress reinforcing steel when the concrete cylinders representing the member to be prestressed reach the compressive strength shown on the approved fabrication drawings.

Stress the prestress reinforcing steel, using jacks, to the specified tension with the stress transferred to the end anchorage.

Measure the tension and elongation at all times.

Make a record of gauge pressures and elongation while post tensioning and submit it to the Project Manager for review.

553.03.13 Bonding Steel. Bond post-tensioned steel to the concrete unless otherwise specified.

Clean all dirt, loose rust, grease, or other deleterious material from all pre-stress reinforcing steel.

Flush all conduits with water and blow them out with compressed air after post-tensioning.

Remove rubber sheaths used as enclosures, then flush and blow out the voids as described above.

Once cleaned, pressure-grout the conduit or void using a pressure not exceeding 100 psi (690 kPa). Continue grouting until a steady flow of grout exits from the pipe outlet. Close the outlet, then the inlet with the grout under pressure . Maintain the final grout pressure at between 50 to 100 psi (345 to 690 kPa).

553.03.14 Concrete Surface Finish. Perform the concrete finish work immediately after de-tensioning. Give the exterior surfaces of exterior members and the entire bottom flange of all girders to the juncture with the beam web an Ordinary Finish as specified in Subsection 552.03.12(A).

All other beam surfaces may be left with the surface created by the forms, if the surfaces are true, even, and free of stone pockets, depressions, or surface projections. Point with mortar and strike off even with the surrounding surface, all air holes in the concrete measuring ½-inch (13 mm) or more in any direction. Repair rough, uneven, and non-uniform concrete surfaces using power grinders, carborundum stones, brushhammers, or other approved equipment and then apply an Ordinary Finish.

Match the appearance of the surface adjacent to the repair. Apply an Ordinary Finish to the entire adjoining surface of the member if a match is not possible.

Repair rock pockets identified for repair. Chip rock pockets back to sound concrete, clean, and permit inspection before patching. Rock pockets affecting the members strength will be further evaluated before repair.

Notify the Inspector of all members having the prestress strand exposed for 8-inches (205 mm) or more on any one strand or any exposure of multiple strands before repair.

Provide an Ordinary Finish on beam ends not embedded in concrete. The Contractor may use approved epoxy or quick-setting grout products, provided the colors blend with the surrounding surface. Before finishing the beam ends, cut the strands back a minimum of ½-inch (13 mm) and fill the depressions with an approved epoxy.

When beam ends will be embedded in concrete, the ends may be left rough and strands cut back to extend a maximum 1-inch (25 mm) beyond the surface of the concrete. Cut the strands in the area of the paving notch flush with the concrete surface.

Screed and rough-float the top surface of prestressed girders to the required depth of the member, bringing grout to the surface, and covering all aggregate.

Clean all projecting reinforcing stirrups of mortar and other foreign materials before starting the cure cycle.

553.03.15 Workmanship and Tolerances. All tolerances are applied to the theoretical positions and dimensions shown on the plans and approved fabrication drawings.

The tolerances listed in Table 553-1 are the total allowable tolerance accepted in the finished product. Tolerances in other manufacturing sequences cannot accumulate to supersede any individual tolerance. Members having dimensions outside the tolerance limits may be rejected.

TABLE 553-1
TOLERANCES FOR PRESTRESSED CONCRETE MEMBERS

ELEMENT	TOLERANCE
Length of beam, end-to-end, measured at centerline of beam, top or bottom flange	± 3/4" (± 20 mm)
Centerline-to-centerline of end bearing plates	1/8" (3 mm) per 10' (3 m) but no greater than ½" (13 mm)
Depth of flanges, fillets, and web	±1/4" (5 mm)
Depth overall	+1/2" (13 mm) to - 1/4" (5 mm)
Width of flanges, fillets, and web	+3/8" (10 mm)to -1/4" (5 mm)
Beam ends - deviation from square or specified skew	Horizontal, ± 1/4" (5 mm) - Vertical, 1/8" (3 mm) per foot of beam height or ½" (13 mm), whichever is less
Side insert, center-to-center and center to beam end	± ½" (13 mm)
Horizontal alignment (deviation from a straight line parallel to centerline of the member measured on the bed immediately after release of prestress)	1/8" (3 mm) per 10'(3 m) of beam length but not greater than 1" (25 mm)
Camber differential between adjacent beams measured at release of prestress. (To be applied only to identical members cast in same line)	1/8" (3 mm) per 10' (3 m) of span to a maximum of 1" (25 mm)
Stirrup bars (specified projection above beam top)	± ½" (13 mm)
Tendon position	±1/4" (5 mm) in center of gravity of strand group and individual tendons
Position of deflection points for deflected strands	± 6" (150 mm)
Position of handling devices along centerline of beam	± 6" (150 mm)
Centerline of bearing plates to end of beam	± 1/4" (5 mm)
Bearing plates (deviation from a plane perpendicular to the vertical axis of the beam)	± 1/16" (2 mm)
Stirrup bars (longitudinal spacing)	± 1" (25 mm)
Position of post-tensioning ducts	± 1/4" (5 mm)

553.03.16 Storage and Transportation. Exercise care during transporting, storing, hoisting, and handling of the precast units to prevent cracking or damage.

Transport precast girders and slabs in an upright position, with the points of support and directions of the reactions with respect to the members being approximately the same during transport and storage as when the members are in the final planned position.

Lift the beams using the lifting eyes. During lifts, use spreaders between slings to eliminate the horizontal component of the lifting force from being applied to the beam. A spreader is not required when the angle between the sling and the top of the beam exceeds 45 degrees.

Do not move prestressed members from the casting yard until the concrete has reached the 28 day strength and the Project Manager has been notified of the intent to transport the beams.

Replace units damaged by improper storing, handling, or transporting at Contractor expense.

553.03.17 Placing. Place precast, prestressed structural members as specified. Place piling under in Section 559.

553.04 METHOD OF MEASUREMENT. Precast, prestressed concrete members, excluding piling, are measured by the linear foot (meter) to the nearest 0.1 foot (0.1 m) for each specified type and/or size, installed and accepted.

Prestress beams are measured by the linear foot (meter) from centerline bearing to centerline bearing to the nearest 0.1 foot (0.1 m).

553.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay item	Pay Unit
Precast Member	Linear Foot (linear meter)
Prestress Member	Linear Foot (linear meter)
Concrete Piling	See Subsection 559.05

Payment at the contract unit price is full compensation for all necessary resources to complete the item of work under the Contract.

SECTION 554
PRECAST CONCRETE PRODUCTS

554.01 DESCRIPTION. This work is the furnishing and installing of reinforced precast concrete bridge members, precast curbs, barrier rails, cattle guard bases, guardrail posts, and other precast concrete products.

554.02 MATERIALS.

554.02.1 Concrete. Furnish portland cement concrete meeting Section 551 requirements.

554.02.2 Reinforcing Steel. Furnish reinforcing steel meeting Section 555 and Subsection 711.01 requirements.

554.02.3 Structural Steel. Furnish Structural steel meeting Subsection 711.02 requirements.

554.03 CONSTRUCTION REQUIREMENTS.

554.03.1 Fabrication Drawings. Submit fabrication drawings and design calculations to the Project Manager for review. Do not begin fabrication until the drawings are returned. The drawings must include the following information:

1. An erection layout with each individual piece identified;
2. The concrete mix design proposed for use in production including proposed admixtures;
3. The size, type, capacity, and location of items incorporated in the member such as chairs, inserts, and other hardware;
4. All other information necessary to fabricate and install the product.

Submit 4 prints of the drawings and calculations initially. After review furnish 3 additional prints of drawings. Furnish prints on 22 X 36-inch paper (A 1 paper) with a 1½-inch (46 mm) margin on the left side and ½-inch (43 mm) margins on the other 3 sides.

554.03.2 Design of Concrete Mixtures. Upon request, the Engineer will furnish a concrete mix design when a specific concrete class is specified. The Contractor may submit a proposed mix design to the Project Manager for approval, in lieu of using the Department-furnished mix design, when concrete is designated by class.

Submit a proposed mix design with the shop drawings to the Project Manager for approval.

The Contractor may request to change aggregate size and gradation to use aggregates in an established plant. Submit the request in writing and include sizes and gradation limits for each size aggregate. Furnish evidence of satisfactory performance of concrete produced from the aggregates. Do not make changes in the aggregates without the Project Manager's approval.

554.03.3 Sampling, Handling, Batching, and Mixing. Sample, handle, batch, and mix materials for concrete under Subsection 551.03.3.

554.03.4 Forms and Forming. Meet the form requirements in Subsection 552.03.4.

554.03.5 Placing Concrete. Place concrete under Subsection 552.03.5.

554.03.6 Curing and Testing Concrete. Cure precast concrete products by water curing, impervious membrane curing, elevated temperature curing, or a combination of these methods.

Perform water curing and impervious membrane curing meeting Subsection 551.03.6 requirements.

Perform Elevated-temperature steam process curing meeting Subsection 553.03.10 requirements.

Submit procedures for curing by the elevated-temperature electric coil process or a combination of methods in writing to the Project Manager for approval before use.

Perform at least 1 test per 50 cubic yards (35 m^3) or per each day's production if less than 50 cubic yards (35 m^3) to verify reaching the compressive strength required to discontinue curing.

A test is the average strengths of 3 cylinders, each cast from different batches of concrete used in the day's production. Take the 3 samples from as many different batches as possible if more than 2 batches are used.

Sample and cast cylinders using MT-101.

Cure until the compressive strength of the standard 6 X 12- inch (152 X 305 mm) cylinders, cured under the same conditions as the concrete represented, reaches the required strength for the class of concrete or the specified strength.

Field-cure cylinders a maximum 28 days and test for compressive strength within 24 hours after removal from the field curing conditions. Perform strength testing under AASHTO T 22. Furnish the Project Manager the certified laboratory test results or arrange for the tests to be witnessed the Department.

Test results are acceptable if the average of the 3 cylinder strengths exceed the strength for the concrete class or the specified strength and no individual cylinder tested has a strength less than 90 percent of the specified strength.

Continue un-interrupted curing until test results are obtained. Should all cylinders be tested without reaching the specified strength, the concrete represented by the cylinders may be rejected.

554.03.7 Cold-Weather Concreting. Furnish concrete at between 60 °F to 90 °F (15 °C to 32 °C) for placing when the air temperature is less than 40 °F (4 °C). Heat the concrete under Subsection 552.03.9(B).

Clear form work of snow, ice, and frost before placing concrete.

Protect the concrete from freezing for at least 48 hours after its placed or until it reaches the strength required to discontinue curing.

After 48 hours, provide freeze protection to develop the required strength.

Construct and protect bridge components meeting Subsection 552.03.9(C) requirements.

Assume all risk of concrete work during cold weather.

554.03.8 Form Removal. Remove lateral support forms only when it will not damage the concrete. Do not interrupt curing and protection in excess of 30 minutes for form removal.

554.03.9 Finish on Exposed Surfaces. Produce concrete surfaces free from rock pockets, depressions, or projections.

Scattered holes from surface trapped air are not considered defects. Point holes larger than ½-inch (13 mm) in any direction with mortar and strike off even with the surface. Apply an ordinary finish to surfaces not smooth and uniform in texture and appearance under Subsection 552.03.12.

554.03.10 Handling, Transporting, and Storage. Do not remove, handle, or transport items designed to carry loads from the casting bed before they reach the required strength.

Other items may be moved from the casting bed to other curing locations when they have reached the strength to prevent damage.

Replace all cracked or broken items at Contractor expense.

Handle, transport, and store precast concrete items without damage. Replace or repair all damaged items at Contractor expense.

554.03.11 Placement. Place precast concrete members as specified.

554.04 METHOD OF MEASUREMENT.

554.04.1 Precast Concrete Curb. Precast concrete curb is measured under Subsection 609.04.

554.04.2 Precast Concrete Median Barrier Rail. Precast concrete median barrier rail is measured under Subsection 606.04.

554.04.3 Plain Reinforced Precast Concrete Bridge Members. Plain reinforced precast concrete bridge members are measured under Subsection 553.04.

554.04.4 Precast Concrete Cattle Guard Bases. Precast concrete cattle guard bases are not measured or paid for separately but are included in the payment for cattle guards under Subsection 611.05.

554.04.5 Precast Concrete Guardrail Posts. Precast concrete guardrail posts are not measured or paid for separately but are included in the payment for metal guardrail under Subsection 606.05.

554.04.6 Other Precast Concrete Products. Other specified precast concrete products are measured and paid for as specified in the Contract.

554.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Precast Concrete Curb	See Subsection 609.05
Precast Concrete Median Barrier Rail	See Subsection 606.05
Precast Concrete Bridge Members	See Subsection 553.05

Payment at the contract unit price is full compensation for all necessary resources to complete the item of work under the Contract.

SECTION 555
REINFORCING STEEL

555.01 DESCRIPTION. This work is furnishing and placing reinforcing steel and wire fabric.

555.02 MATERIALS. Furnish materials meeting the following Subsection requirements:

Reinforcing Steel 711.01.1
Epoxy-Coated Reinforcing Bars 711.01.2
Wire and Wire mesh 711.01.3

555.03 CONSTRUCTION REQUIREMENTS.

555.03.1 Protection of Material. Protect reinforcing steel from damage. Store reinforcing and supports on blocks.

Handle epoxy-coated steel reinforcing with padded or nonmetallic slings and padded straps to prevent damage to the epoxy coating. Store the bars on wooden cribs. Damaged material will be rejected, or repaired meeting AASHTO M 284 at Contractor expense.

555.03.2 Fabrication. Bend reinforcing bar as specified in the Contract.

Bend all bars cold. Do not field bend bars partially imbedded in concrete unless otherwise specified.

Meet Table 555-1 bend radii for standard hooks and all other bars other than stirrups and ties. Provide a minimum inside radii of 2 bar diameters for stirrups and ties.

TABLE 555-1
MINIMUM BENDING RADII

BAR SIZE	MINIMUM INSIDE RADII
3 thru 8 (10M thru 25M)	3 bar diameters
9 thru 11 (30M and 35M)	4 bar diameters
14 or 18 (45M and 55M)	5 bar diameters

Obtain the Project Manager's approval for special fabrication or bends exceeding 90 degrees for No's. 14S and 18S reinforcing steel.

Ship reinforcing bar in bundles tagged and marked meeting the Concrete Reinforcement Steel Institute Code of Standard Practice.

Submit fabrication drawings when specified or requested.

555.03.3 Placing and Fastening. Place the reinforcing steel as shown in the Contract and hold in place during concrete work.

Assure steel reinforcing is free of loose rust and scale, dirt, paint, oil, or other foreign material.

Verify the anchor bolt clearances before placing reinforcing steel.

Tie bars at all intersections unless bar spacing is less than 1 foot (305 mm) in each direction, which requires alternate intersections be tied.

Provide the minimum cover for reinforcing bars shown in Table 555-2.

TABLE 555-2
MINIMUM BAR EMBEDMENT

Top of Slab	2 3/8-inches (60 mm)
Bottom of Slab	1-inch (25 mm)
Stirrups and Ties	1 ½-inches (38 mm)
Footing and Pier Shafts	3-inches (75 mm)

Separate forms using stays, ties, hangers, metal chairs, blocks, or other approved supports.

Precast mortar blocks may be used at locations approved by the Project Manager, excluding supports for bridge deck slab reinforcing steel. Use blocks precast from concrete used on the project and water cured for 7 days before use. Use blocks of the size specified having an embedded wire for fastening to the reinforcing bar. Separate bar layers using precast mortar blocks, upper continuous metal chairs, or other approved devices.

Separate the upper and lower mats of reinforcing steel for deck slabs, depending upon the vertical distance between the mats, using "Upper Continuous High Chair (U.C.H.C.)" or "Slab Bolsters with Runners (S.B.R.)". Place Continuous bar supports at right angles to structure centerline for "Flat Slab" structures and parallel to structure centerline for all other deck slabs. Do not use pebbles, pieces of broken stone, concrete rubble, broken brick or building blocks, metal pipe, or wooden blocks.

Use metal chairs and supports contacting epoxy-coated bars that are epoxy coated or coated with another inert approved coating.

Use plastic-coated tie wires to tie the coated bars in place.

Space deck slab reinforcing supports a maximum 4 feet (1200 mm). Space supports closer if necessary to prevent deflection during placement of concrete.

Obtain the Project Manager's approval of reinforcing placement before placing concrete. Remove concrete placed before inspection.

Flatten rolled reinforcing fabric into sheets before placing.

555.03.4 Splicing. Furnish all reinforcing steel in the specified lengths. Splice as shown in the contract or as directed.

555.03.5 Reinforcing Steel-Material Guaranty & Random Sampling. Furnish for each shipment of reinforcing steel delivered to the project, duplicate copies of the following:

1. Shipping invoice showing the weight and price per pound (kilogram) of all of the steel in the shipment;
2. Certified mill test reports showing physical and chemical analysis on each heat of reinforcing steel;

3. A statement from the fabricator certifying that the mill tests furnished are representative of the reinforcing steel furnished and that it meets Subsection 106.09 requirements;
4. For epoxy-coated reinforcing bars, the coating applicator must furnish with each shipment 2 copies of a certificate of compliance confirming that the coated reinforcing bars were cleaned, coated, and tested meeting the requirements of AASHTO M 284 and Subsection 106.09. Additionally, the certification must include for each bar size the preheat temperatures, cure times, thickness checks, holidays detected, and bend test results. Submit 1 copy of this certification to the laboratory.

A shipment is the quantity of reinforcing steel in each truckload delivered to the project. When delivery is by railroad car, each 20 tons (18.1 mt), or fraction thereof, is a shipment.

Furnish the samples as requested for testing.

Do not place concrete until the steel test results are known. If a reinforcing steel sample fails, two additional samples representing the failed sample will be tested. If either of the check samples fail, the steel in the shipment represented by the failing sample may be rejected; or if the Project Manager determines that the steel is usable, a price reduction will be assessed as follows:

$$P = A \times B$$

Where:

A = Total invoice price of reinforcing steel in the lot.*

B = 10%, 20%, or 30%, dependent upon departure from specifications. The value to be used will be determined by the Engineer.

P = Price reduction for the lot.

* A lot is defined as all the bars of one bar number and pattern of deformation contained in an individual shipment.

The amount of reduction calculated above will be deducted from monies due the Contractor on the final estimate.

Remove and replace all rejected steel at Contractor expense. Furnish invoice statements, mill reports, and fabrication certificates for replacement steel. Replacement steel is subject to the tests specified above.

No reinforcing steel in a shipment will be final accepted until the test results are known. The Contractor may proceed with the work at its own risk before testing.

555.04 METHOD OF MEASUREMENT. The reinforcing steel quantity in the Contract is the calculated theoretical weight of the steel in pounds (kilograms), measured as shown in the contract or ordered in writing, complete in place and accepted.

Plan quantities will not be re-measured except as provided for in Subsection 555.05.

The weights of standard sizes of reinforcing bars meeting the requirements of AASHTO M 31 are computed using Table 555-3.

TABLE 555-3
WEIGHTS OF STANDARD SIZES OF REINFORCING BARS

BAR SIZE	WEIGHT
No. 3 Bars	0.376 Lb Per Foot
No. 4 Bars	0.668 Lb Per Foot
No. 5 Bars	1.043 Lb Per Foot
No. 6 Bars	1.052 Lb Per Foot
No. 7 Bars	2.044 Lb Per Foot
No. 8 Bars	2.670 Lb Per Foot
No. 9 Bars	3.400 Lb Per Foot
No. 10 Bars	4.303 Lb Per Foot
No. 11 Bars	5.313 Lb Per Foot
No. 14 Bars	7.650 Lb Per Foot
No. 18 Bars	13.600 Lb Per Foot
(METRIC)	
BAR SIZE	**MASS**
# 10M Bars	0.785 kg/m
# 15M Bars	1.570 kg/m
# 20M Bars	2.355 kg/m
# 25M Bars	3.925 kg/m
# 30M Bars	5.495 kg/m
# 35M bars	7.850 kg/m
# 45M Bars	11.775 kg/m
# 55M Bars	19.625 kg/m

Non-standard reinforcing bars or wire fabric, when required, have the unit weight specified in the contract.

No allowance is made for clips, wires, separators, or other material used for fastening or supporting the reinforcing steel.

555.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Reinforcing Steel	Pound (kilogram)

Reinforcing steel is paid in place for the quantities shown in the Contract, except as follows:

1. The calculated quantities involved in changes ordered in writing by the Engineer are added or deducted from the plan quantities;
2. A recalculation will be made and the corrected quantity will be included for payment, in lieu of the plan quantity, when the plan quantity of reinforcing steel in any complete structure is in error by five percent or more. A complete structure is the smallest portion of a total structure for which a quantity is included in the Contract. The party to the Contract requesting an adjustment shall present to the other party three copies of the description, location and recalculated quantities of the structure having the quantity error.

The following percentages of the total quantity of reinforcing steel in place is paid on progress estimates:

1. 85% when placed and tied;
2. 90% when covered with concrete;
3. 100% when random tests are complete and the material is accepted.

Payment at the contract unit price is full compensation for all necessary resources to complete the item of work under the Contract.

SECTION 556
STEEL STRUCTURES

556.01 DESCRIPTION. This work is the furnishing, fabricating, painting, and erecting of steel structures and the steel structure portions of composite structures.

The Department has calculated the contract quantities using the following:

Material	Weight per foot (meter)
Malleable Iron	470 lbs (700 kg/m)
Wrought Iron	487 lbs (725 kg/m)
Steel, rolled, cast copper bearing, silicon nickel, and stainless	490 lbs (729 kg/m)

The weights of rolled shapes and plates up to and including 36-inches (915 mm) in width are computed based on their nominal weights and dimensions as shown on the shop drawings. One-half of the allowed percentage of overrun in weight as tabulated in ASTM A 6 will be added to the nominal weights of plates exceeding 36-inches (915 mm) in width. The weight is computed on the basis of rectangular dimensions for all plates and overall lengths for all structural shapes with no deductions for copes, slips, sheared edges, punching, borings, milling, or planing. When parts can be economically cut in multiples from materials of larger dimension, the calculated weight is that of the material from which the parts are cut.

Bolts, nuts, and washer weights are the calculated weight in the AISC Manual of Steel Construction.

A 0.4% multiplier may be specified in the Contract and added to the computed weight of metals for shop paint.

Weld metal weight is computed on the theoretical volume of the weld dimensions. A 50% allowance is added to the weight for overrun.

556.02 MATERIALS. Furnish materials meeting the following Subsections:

Structural Steel	711.02
Structural Steel Tubing	711.03
Pins and Rollers	711.04
Welding Electrodes	711.05
High Tensile Strength Bolts	711.06
Bolts and Nuts	711.07
Galvanized Metal	711.08
Welded Stud Shear Connectors	711.09
Castings	711.12
Fiber-Reinforced Pads for Bearing Plates	711.16
Bearing Assembly Anchor Bolts for Bridges	711.13
Elastomeric Bearing Devices	711.14
Compression Joint Seals	711.15

556.03 CONSTRUCTION REQUIREMENTS.

556.03.1 Pre-qualification. Metal fabricators must be pre-qualified under the AISC Quality Certification Program. Registration and certification of the plant or shop under the AISC program, Category I, II, or III, and submission of a valid certificate to the Bridge Engineer, MDT, 2701 Prospect Avenue, Helena, MT, 59620-1001, is required. Furnish an annual endorsed copy for continued qualification.

Use only fabricators having a Category III certification to fabricate the following:

1. Fracture critical members and attachments (Certified Fractures Critical);
2. Main members, except for rolled beams;
3. Welded floorbeams;
4. Cross frames and diaphragms for curved bridges.

Use fabricators having a Category I, II, or III certification to fabricate the following:

1. Modular Expansion joints;
2. Welded bearings;
3. Steel grid flooring;
4. Overhead, Truss, and cantilever sign structures;
5. Lighting poles and anchor bases.

Materials not requiring shop fabrication or shop welding, such as plates and shapes for strengthening existing bridges and manufactured items are accepted by certification.

556.03.2 Fabrication Drawings. Submit 5 copies of the fabrication drawings to the Project Manager for review. Include on the drawings complete details, dimensions, size of material, welding procedures, and other information necessary for the complete fabrication and erection of the work.

Check and approve fabrication drawings before submitting them to the Project Manager. Assure the Contractor's approval stamp and signature is on each drawing.

The Project Manager must review the Drawings before fabrication begins. The Department has 20 working days to review and return the fabrication drawings. The Contract time will be extended day for day for any delay beyond the 20 day review period.

Furnish 3 or more approved copies of the drawings after the Project Manager's review. Furnish all fabrication drawings on 22 X 36-inches (A1 paper) with a 1 ½-inch (46 mm) margin on the left side and a ½-inch (43 mm) margin on the other 3 sides. Once the work is completed, provide the original tracings, if required, to the Project Manager.

Changes to the plans or substitutions of sections requested by the Contractor regarding plate size, splice location, details of appurtenances, or details of welds cannot decrease the dimensions or section properties of the member or increase the weight of the member.

Submit all requests for changes to the Project manager for review and approval. All approved changes are at the Contractor's expense, including any additional freight and handling charges. The approved changes will be by change order, and include any cost savings.

556.03.3 Mill and Shop Inspection.

A. **Inspection of Work.** Do not begin manufacturing or shop fabrication until the Departments inspector has inspected the shop.

B. **Facilities for Inspection.** Furnish facilities for inspecting the material and workmanship in the mill and shop. Allow the Inspector free access to the work at all times.

C. **Inspector's Authority.** The Inspector may reject material or work not meeting the specifications. In case of dispute, the Contractor may appeal the inspector's decision to the Project Manager.

D. **Mill Test Reports.** Furnish the Project Manager a complete certified mill test report showing chemical analysis and physical tests for each heat of steel for all members. Identify each piece of steel with a mark number on the mill test report.

E. **Facilities for Testing.** Furnish, at Contractor expense, test specimens, labor, testing machines, and tools to make the specimens and tests.

F. **Rejections.** Material or finished members accepted by the Inspector may be rejected if the material is subsequently found defective. Replace or repair rejected material at Contractor expense.

556.03.4 Storage and Identification of Materials. Store structural steel meeting Subsection 556.03.17 requirements.

Mark alloy and high-strength steels as required by Article 11.4.1 of the AASHTO Standard Specifications for Highway Bridges. Mark material required to meet a Charpy requirement for identification.

556.03.5 Workmanship and Finish. Round all edges of primary members corners to a 1/16-inch (2 mm) radius.

Make all surfaces and edges smooth, uniform, and free from fins, tears, and cracks.

Shear, flame cut, and chip neatly and accurately. Neatly finish all exposed portions of the work.

Straighten rolled material before lay out or working. Do not injure the metal when straightening. The maximum temperature of the steel cannot exceed 1000 °F (537 °C) unless approved. Perform heat straightening of AASHTO M 270 Gr. 100/100w (ASTM A 709 Gr 100/100w) or ASTM A 517 steel only under controlled procedures with the heat application approved by the Project Manager. Material with sharp kinks and bends will be rejected.

Lay out and cut plates and splice plates for flanges and webs with the direction of rolling parallel to the longitudinal axis of the girder. Show on the shop drawings the direction of rolling for these plates.

Curve rolled beams and welded girders meeting Articles 11.4.12.2 and 11.4.7 of the AASHTO Standard Specifications for Highway Bridges.

556.03.6 Finishing and Shaping. Finish members true to line, free from twists, bends, and open joints. Camber girders as shown on the plans.

A. **Edge Planing.** Plane sheared plate edges exceeding 5/8-inch (16 mm) in thickness and carrying stress to 1/4-inch (5 mm). Fillet re-entrant cuts before cutting.

B. Facing of Bearing Surfaces. For bearing, base plates and other bearing surfaces in contact with other members or with concrete, meet the surface-roughness requirements of Table 556-1.

TABLE 556-1
SURFACE-ROUGHNESS REQUIREMENTS*

Steel slabs	ANSI 2,000 (50 μm)
Heavy plates in contact in shoes to be welded	ANSI 1,000 (25 μm)
Milled ends of compression members, stiffeners, and fillers	AMS500 (12.5 μm)
Bridge rollers and rockers	ANSI 250 (6.3 μm)
Pins and pin holes	ANSI 125 (3.2 μm)
Sliding bearings	ANSI 125 (3.2 μm)

*As defined in ANSI B Y 14.36-1978 Surface Roughness, Waviness, and Lay, Part I

Stress relieve shoes meeting AWS specifications after all welding and before pin holes are drilled or curved bearing surfaces are finished.

C. Abutting Joints. Face and bring to an even bearing, abutting joints in compression members, girder flanges, and tension members, if specified. Joints not faced must have an opening not exceeding 1/4-inch (5 mm).

D. End Connection Angles. Build floor beams, stringers, and girders with end connection angles to exact length back-to-back of connection angles. Assure the finished thickness of the angles is at least that shown on the plans if end connections are faced.

E. Web Plates. Do not exceed a 3/8-inch (10 mm) clearance at web splices between the ends of the web plates. Do not exceed 1/4-inch (5 mm) clearance at the top and bottom ends of the web splice plates.

F. Bent Plates. Furnish cold-bent, load-carrying, rolled-steel plates meeting the following requirements:

1. Use stock plates that place the bend lines at right angles to the direction of rolling.
2. Bending must not crack the plate. Meet minimum bending radii, measured to the concave face of the metal, as specified in Table 556-2.

TABLE 556-2
MINIMUM BENDING RADII - ROLLED STEEL PLATES

	THICKNESS OF PLATE IN INCHES (MM)				
	Up to ½ (12mm)	Over ½ to 1 (12 mm to 25 mm)	Over 1 to 1½ (25 mm to 38 mm)	Over 1½ to 2½ (38 mm to 63.5 mm)	Over 2½ to 4 (66 mm to 100 mm)
Bending Radii**	2t*	2½t*	3t*	3½t*	4t*

* t = plate thickness
** For all grades of structural steel in this specification.

Hot bend low alloy steel over ½-inch (12 mm) thick for small radii if required.

Springback allowance for AASHTO M 270 Gr. 100/100w (ASTM A 709 Grade 100/100w) and ASTM A 517 steels is about 3 times that for structural carbon steel. When break press forming, use a lower die span at least 16 times the plate thickness.

Hot bend the plates at a temperature not exceeding 1200 °F (649 °C), excluding AASHTO M 270 Grade 100/100w (ASTM A 709 Grade 100/100w) and ASTM A 517 steels if a shorter radius is required. Re-quench the plates and temper following the mill's common practice if AASHTO M 270 Grade 100/100w (ASTM A 709 Grade 100/100w) or ASTM A 517 steel plates to be bent are heated to a temperature exceeding 1125 °F (607 °C). Hot bent plates must meet requirement (1) above.

3. Round the corners of the plate to a radius of 1/16-inch (2 mm) throughout the area to be bent.

G. **Fit of Stiffeners.** Mill or grind end stiffener plates or girder and stiffener angles for use as supports for concentrated loads to provide an even bearing against the flange. Make fillers under stiffeners to fit within 1/4-inch (5 mm) at each end. Welding is permitted in lieu of milling or grinding if noted in the Contract. Welding transversely across the tension flanges of beams or girders is permitted only with the Project Manager's approval.

Horizontal stiffeners must not leave a gap exceeding 2-inches (50 mm) between the vertical stiffeners and the end of the horizontal stiffeners.

H. **Flame Cutting.** Steel or wrought iron may be flame cut, if a smooth surface is produced using a mechanical guide. Perform hand flame cutting only where approved, smoothing the surface by planing, chipping, or grinding. Adjust the cutting flame to prevent cutting beyond the specified lines. Make fillet re-entrant cuts having a minimum radius of ½-inch (10 mm).

Remove flame-cut edges back at least 1/4-inch (5 mm) by milling, chipping, or grinding for silicon steel. Machine flame-cut edges may be used as cut if the edges are softened after cutting by either of the following methods:

1. Heat the cut edge uniformly and progressively to a red heat (1150 °F to 1250 °F) (621 °to 676 ° C) to at least 1/16-inch (2 mm) deep;
2. Using a post-heating torch attached to and following the cutting torch; regulate the tips, gas pressure, speed of travel, and the distance of post-heating torch from kerf to the thickness of the steel.

556.03.7 Pins and Rollers.

A. **General.** Furnish straight, smooth pins and rollers meeting the specified dimensions, free from flaws. Forge and anneal pins and rollers more than 9-inches (225 mm) in diameter. Pins and rollers 9-inches (225 mm) in diameter or less may be forged and annealed or cold-finished carbon-steel shaft.

Gradually cool pins 9-inches (225 mm) in diameter or larger to prevent damage before annealing. Bore a hole 2-inches (50 mm) or larger in diameter the full length along the axis.

B. **Boring Pin holes.** Bore pin holes to the specified diameter at right angles with the axis of the member, and parallel with each other unless otherwise specified. Finish cut the final surface.

Maintain a tolerance of ± 1/32-inch (1 mm) for outside-to-outside of end holes in tension members and inside-to-inside of end holes in compression members.

Bore holes in built-up members after the welding is completed.

C. **Pin Clearances.** Meet the following pin hole diameter maximum tolerances:
   1. The pin diameter plus 1/50-inch (0.5 mm) for pins 5-inches (125 mm) or less in diameter;
   2. 1/32-inch (1 mm) for larger pins.

D. **Surface Finish.** Finish surfaces of bridge rollers, rockers, pins and pin holes meeting Subsection 556.03.6(B) requirements.

E. **Pilot and Driving Nuts.** Furnish 2 pilot nuts and 2 driving nuts for each size of pin unless otherwise specified. Pilot and driving nuts are not required when shoes are assembled at the fabrication plant.

F. **Threads.** Use Unified Standard Series UNC - ANSI B1.1, Class 2A threads for external threads, and Class 2B for internal threads, for all imperial dimension bolts and pins for structural steel construction, except for pin end diameters of 1⅜-inches (35 mm) or more which must be 6 threads to the inch (25 mm).

Furnish American Standard Metric Screw Treads - M Profile, ANSI B1.13M-1983 for all metric dimension bolts and pins for structural steel construction. Tolerance is Class 6H/6g. Use a 4 mm pitch for pin end diameters of 35 mm or more.

556.03.8 Bolt Holes.

A. General. Punch or drill all bolts holes.

Members built up with 5 thicknesses or less of metal may be punched 1/16-inch (2 mm) larger than the nominal diameter of the bolt, if the metal thickness does not exceed 3/4-inch (19 mm) for carbon steel or 5/8-inch (16 mm) for alloy steel.

Sub-punch or sub-drill all holes 3/16-inch (5 mm) or smaller for members exceeding 5 thicknesses, where the material is 3/4-inch (19 mm) carbon steel or thicker, or 5/8-inch (16 mm) in alloy steel. Ream the holes 1/16-inch (2 mm) larger. The holes may be drilled from the solid to 1/16- inch (2 mm) larger than the nominal diameter or the bolts.

B. Punched Holes. Make holes, punched full size, 1/16-inch (2 mm) larger than the nominal diameter of the bolt. The die diameter cannot exceed the diameter of the punch by more than 1/16-inch (2 mm).

Ream undersized holes. Clean-cut holes without torn or ragged edges. Poorly matched holes will be rejected.

C. Accuracy of Punched and Sub-drilled Holes. Punch all holes, punched full size, sub-punched, or sub-drilled so that after assembling (before any reaming is done) a cylindrical pin 1/8-inch (3 mm) smaller in diameter than the nominal size of the punched hole will enter without drifting, in at least 75 percent of the contiguous holes in the same plane. Any hole that will not pass a pin 3/16-inch (5 mm) smaller in diameter than the nominal size of the punched hole will be rejected.

D. Reamed or Drilled Holes. Ream or drill all holes, perpendicular to the member, and not to exceed 1/16-inch (2 mm) larger than the nominal diameter of the bolts. Where practical, use mechanically directed reamers.

Drill holes 1/16-inch (2 mm) larger than the nominal diameter of the bolts.

Remove all outside surface burrs. Poorly matched holes will be rejected. Use twist drills for reaming and drilling. Disassemble assembled parts to remove burrs caused by drilling. Assemble connecting parts to be reamed or drilled and held during the work, then match-mark before disassembling.

E. Accuracy of Reamed and Drilled Holes. Eighty-five percent of reamed or drilled holes in any contiguous group must not exceed a 1/32-inch (0.8 mm) offset between adjacent thicknesses of metal.

556.03.9 Bolts and Bolted Connections.

A. General. Make bolted connections meeting the Contract requirements. Use unfinished bolts (ordinary rough or machine bolts). Provide turned bolts when specified. Special ribbed drive-fit bolts may be substituted for turned bolts with the Project Manager's written approval.

Provide bolted connections, using high-tensile-strength bolts, meeting Subsection 556.03.9(E) requirements.

Furnish bolts that are free of rust. Lubricate bolts before use.

Drive the bolts into the holes without damaging the thread. Use snaps to prevent damaging the heads.

Draw the heads and nuts tightly against the work with wrenches. Tap bolt heads with a hammer as the nuts are being tightened.

Use beveled washers to provide full bearing to the head or nut where bolts are used on beveled surfaces.

All bolts threads must be cut and finished.

Fully draw up the nuts of unfinished turned bolts and ribbed bolts after tightening.

Fully erect continuously supported girder sections between expansion joints before production bolt tightening. Tighten field splices to the proof loads in Table 556-5 after field splices have been set to grade.

B. Unfinished Bolts. Furnish standard unfinished bolts having hexagonal heads; with nuts having a bolt hole diameter 1/16-inch (2 mm) larger than the bolt diameter. Use threaded bolts, for transferring shear, to prevent no more than one thread within the grip of the metal. Furnish bolts that extend through the nuts a maximum 1/4-inch (6 mm).

C. Turned Bolts. Ream turned bolt holes, and turn the bolts to a driving fit with the threads entirely outside of the holes. Use hexagonal headed bolts and nuts and provide washers. Turned bolts must be finished cut.

D. Spacing and Edge Distance of Bolts. Follow the spacing and edge distance of bolts specified in Table 556-3.

TABLE 556-3
SPACING AND EDGE DISTANCE OF BOLTS

BOLT LOCATION	BOLT SIZE			
	1" M 24 mm	7/8" M 22 mm	3/4" M 20 mm	5/8" M 16 mm
	Spacing or Distance - Inches			
Minimum Spacing of Bolts Center-to-Center	3½" 90 mm	3" 75 mm	2½" 65 mm	2¼" 55 mm
Minimum Distance From Center of Bolt to Nearest Sheared Edge and to Edges of Beams and Channels	1¾" 45 mm	1½" 40 mm	1¼" 30 mm	1⅛" 25 mm
Minimum Distance From Center of Bolt to Nearest Rolled or Planed Edge	1½" 40 mm	1¼" 30 mm	1⅛" 25 mm	1" 25 mm
Maximum Distance From Center of Bolt to Nearest Edge	Eight times the thickness of the thinnest outside plate but not greater than 5" (125 mm) for all bolt sizes			

E. Bolted Connections - High-Tensile-Strength Bolts.

1. **Bolt Lengths.** Use bolt lengths having the grip-length values in Table 556-4 plus the total thickness of connected material. The values in Table 556-4 consider nut, one flat washer, and bolt point.

Adjust the length to the next 1/4-inch (10 mm) increment up to a 5-inch (120 mm) bolt and to the next ½-inch (10 mm) increment for bolts over 5-inches (120 mm).

Increase the bolt length ⅛-inch (3.2 mm) if direct tension indicator washers are used.

TABLE 556-4
BOLT LENGTH DETERMINATION

BOLT DIAMETER	ADDED GRIP LENGTH*
½" (13 mm)	7/8" (22 mm)
5/8" (16 mm)	1" (25 mm)
3/4" (19 mm)	1⅛" (29 mm)
7/8" (22 mm)	1⅜" (35 mm)
1" (25 mm)	1½" (38 mm)
1⅛" (29mm)	1⅝" (41 mm)
1¼" (32 mm)	1¾" (44 mm)

*To be added to total thickness of connected material.

TABLE 556-4 METRIC
BOLT LENGTH DETERMINATION

BOLT DIAMETER	ADDED GRIP LENGTH
M16 mm	25 mm
M20 mm	30 mm
M22 mm	35 mm
M24 mm	40 mm

Where beveled washers are used, adjust bolt lengths to account for the use of nonstandard or beveled washers.

2. **Bolted Parts.** Assure bolted surfaces in contact with the bolt head and nut do not have a slope of more than 1:20 to a plane normal to the bolt axis.

   Assure bolted parts fit solidly when assembled without gaskets or other compressible material.

   Remove all mill scale, dirt, burrs, and other defects that prevent solid seating of the parts.

   Clean contact surfaces of oil, paint, lacquer, or galvanizing.

3. **Installation.** Install bolts with a hardened washer under the nut or bolt head, whichever element is turned in tightening. Use a hardened washer under the head of regular, semi-finished hexagon bolts and under finished hexagon nuts, even when these are not the elements turned in tightening. Washers may be omitted under the head of heavy hexagon bolts and interference-body bolts and under heavy, semifinished hexagon nuts, when these are not turned. A flat washer

may be used when the surface adjacent to the bolt head or nut does not have a slope greater than 1:20 to a plane normal to the bolt axis. Use a smooth beveled washer where the outer face of the bolted parts has a slope greater than 1:20 to a plane normal to the bolt axis.

Tighten each fastener to provide the minimum tension in Table 556-5 when all fasteners in the joint are tight.

Tighten threaded bolts as specified in Subsections 556.03.9(E)(3)(a) or (b). Turn the bolt if the nut is prevented from rotating because of clearance problems.

TABLE 556-5
FASTENER TENSION

BOLT SIZE INCHES (mm)		*MINIMUM FASTENER TENSION POUNDS (A 325 BOLTS) (kN)	
1/2	(13 mm)	12,050	(53.5 kN)
5/8	(16 mm)	19,200	(85.3 kN)
3/4	(19 mm)	28,400	(126.2 kN)
7/8	(22 mm)	39,250	(174.4 kN)
1	(25 mm)	51,500	(228.9 kN)
1-1/8	(29 mm)	56,450	(250.9 kN)
1-1/4	(32 mm)	71,700	(318.7 kN)
1-3/8	(35 mm)	85,450	(379.8 kN)
1-1/2	(38 mm)	104,000	(462.2 kN)

* Equal to 70 percent of specified minimum tensile strengths of bolts.

TABLE 556-5 METRIC
FASTENER TENSION

BOLT SIZE (mm)	MINIMUM FASTENER TENSION
M 16 mm	94.2 kN
M 20 mm	147 kN
M 22 mm	182 kN
M 24 mm	212 kN

Impact wrenches perform the required tightening of each bolt in approximately ten seconds.

a. **Turn-of-Nut Tightening.** Bring a minimum 50% of the bolts up snug tight. Then bring the remaining bolts up snug tight. Then tighten all bolts starting with the inside bolts working towards the free edge under Table 556-6. Permit only the element being tightened to turn. Obtain the Project Manager's approval of the tightening method.

TABLE 556-6
NUT ROTATION FROM SNUG TIGHT CONDITION

Bolt length (as measured from underside of head to extreme end of point	DISPOSITION OF OUTER FACES OF BOLTED PARTS		
	Both faces normal to bolt axis	One Face normal to bolt axis and other face sloped not more than 1:20 (bevel washers not used	Both faces sloped not more than 1:20 from normal to bolt axis (bevel washers not used)
Up to and including 4 diameters	1/3 turn	1/2 turn	2/3 turn
Over 4 diameters but not exceeding 8	1/2 turn	2/3 turn	5/6 turn
Over 8 diameters but not exceeding 12	2/3 turn	5/6 turn	1 turn

Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. For bolts tightened by one-half turn and less, the tolerance is plus or minus 30° (1/12 turn); for bolts tightened by two-thirds turn or more, the tolerance is plus or minus 45° (1/8 turn).

The rotation for bolts exceeding twelve diameters is by testing representative bolts in a tension device.

b. **Calibrated Wrench Tightening.** Provide bolt tension at least 5% more than the tension specified using calibrated wrenches. Calibrate wrenches at least once each working day for each bolt diameter installed. Re-calibrate wrenches when equipment changes or when differences in the surface condition of the bolts, nuts, or washers is observed. Calibrate by tightening 3 bolts of each diameter, in a Skidmore-Wilhelm calibrator or approved equal.

Adjust the wrenches to prevent nut or bolt rotation from exceeding that specified in Table 556-6. Tighten the nuts to the specified torque when using manual torque wrenches.

When using calibrated torque wrenches to install bolts in one joint, check the bolts with the wrench after initial tightening of all bolts.

Adjust power wrenches to stall or cut out at the required tension.

4. **Inspection.** The bolt installation will be inspected to verify procedures and results.

   Bolt tension is checked in each connection by applying the job inspection torque to at least 10% of the bolts, but not less than 2. If any element is below the job inspection torque, re-torque all bolts in the connection. Tighten and re-inspect any element turned by the job inspecting torque. As an alternate, the Contractor may re-tighten all bolts in the connection and request a re-inspection of the connection.

   Assist the inspector with bolt tension checks. Provide an approved torque wrench as the inspection wrench. The Inspector will observe the wrench readout as the bolt is being checked.

   The job inspection torque is established from 3 bolts of the same grade, size, and condition as those in the work. The bolt length may be any length representing bolt lengths used in the structure. A new inspecting torque is established when the bolt grade, size, or condition changes. Place the bolts in an approved calibration device that will indicate bolt tension. Use the same surface under the nut and bolt for testing as that used in the structure when establishing the inspection torque.

   Bring the 3 bolts to an initial tension of approximately 15% of the fastener tension in Table 556-5, then tighten to the minimum tension in Table 556-5. Tightening above the initial tension must not cause nut rotation beyond that permitted in Table 556-6. Turn the turned element 5° (approximately 1-inch (25 mm) at a 12-inch (300 mm) radius and read the applied torque. The average of the torque readings in the 3 tests is the job inspection torque.

556.03.10 Welding Requirements. Meet the current requirements of the American National Standard Bridge Welding Code, ANSI, AASHTO, the AWS Structural Welding Code, and the Contract. Use AWS certified welders for the type of weld required.

556.03.11 Welded Stud Shear Connectors. The type, size or diameter, and length of stud shear connectors are specified in the Contract.

Furnish fabrication material and perform welding meeting Subsection 556.03.10 requirements.

556.03.12 Field Welding. Do not weld temporary construction supports to beams, girders, or other main members. Unauthorized field welds, tack welds, or arc strikes to any member will be rejected.

556.03.13 Assembling Steel. Field or shop assemble steel parts as follows:

A. **Shop Work.** Clean all contacting metal surfaces of deleterious materials before assembling, bolting, or welding. Paint may be applied to contact surfaces after bolting or welding.

   Shop assemble and adjust to line and camber all bolted trusses, continuous plate girders, curved steel elements, box girders, I-beam spans, skew portals, skew connections, rigid frames, bents, and towers.

Drill and ream the field splice holes during assembly. Holes for other field connections may be shop drilled or reamed with the connecting parts assembled or drilled or reamed to metal templates with hardened bushings, without assembling.

Use an approved alternate procedure where shop space prevents complete shop assembly of continuous span girders or trusses. The procedure may require adjusting the line and camber of at least two abutting sections of girder for drilling or reaming of field splices if all girder lines for the complete structure are assembled consecutively.

Field butt joints for welded girders may be assembled with abutting members adjusted for line and camber and prepared to fit for welding, subject to Project Manager approval.

Bridge expansion devices must be initially shop assembled to establish the proper fit between the joint parts.

B. Field Work. Assemble the parts as specified in the Contract, following the match-marks. Prevent damaging the material while handling. Clean bearing surfaces and all member surfaces in permanent contact before assembly.

Splices and field connections must have a minimum of one-half of the holes filled with bolts or erection pins before removing temporary supports or releasing the load from erecting equipment. Splices and connections carrying traffic during erection must have three-fourths of the holes pinned or bolted.

Do not begin production bolt tightening of the field splice bolts until the complete girder line is aligned and erected matching the full camber line.

Use erection pins 1/32-inch (1 mm) larger than the nominal diameter of the permanent bolts.

Erect truss spans on blocking, unless they are erected using the cantilever method, to provide truss camber. Leave the blocking in place until the tension cord splices are fully bolted and all other truss connections pinned and bolted. Do not tension bolts in butt joint splices of compression members and in railings until the span is swung.

C. Drifting of Holes. Only use drift pins during assembly to the extent necessary to bring the parts into position without enlarging or distorting the holes or metal. Enlarge holes by reaming to fit the bolts.

D. Match-marking. Match-mark parts assembled in the shop for reaming field connection holes and furnish the Project Manager a diagram showing the marks.

556.03.14 Marking and Shipping. Paint or mark each member with an erection mark, and furnish the Project Manager an erection diagram detailing the erection marks.

Furnish the Project Manager copies of material orders, shipping statements, and erection diagrams. Show the individual member weights on the statements.

A shipping statement must accompany the material and be marked to clearly identify it with the delivered material and mill test reports.

Mark the weight on members weighing 3 tons (2.7 mt) or more. Load and unload structural members on trucks or cars without stressing or causing damage.

Pack bolts, loose nuts or washers of each size separately. Ship pins, small parts, bolts, washers, and nuts in boxes, crates, kegs, or barrels, with the gross weight of each package not exceeding 300 pounds (136 kg). Plainly mark each shipping container, listing and describing the contents on the outside of each shipping container.

Keep structural material clean and free from damage.

556.03.15 Painting. Clean and paint all iron and steel surfaces meeting Section 612 requirements.

556.03.16 Erection. Erect the members using the camber diagrams on the drawings and complete the structure or structures as specified.

When requested, furnish the Project Manager erection details before starting the work.

Support girders and beams at intervals that maintain camber, elevation, and horizontal alignment during final grading, bolt-up, and field splice tightening.

556.03.17 Handling and Storing Materials. Store materials off the ground and keep them clean and dry. Place and shore girders and beams upright. Support long members, including but not limited to columns, chords, and girders, on blocks spaced to prevent deflection. For erection contracts, check the material received against the shipping lists and report in writing all shortages and damaged materials. Be responsible for lost or damaged material while in Contractor possession.

556.03.18 Falsework. Design, construct, and maintain falsework to support the maximum construction loadings. Check and approve falsework drawings and submit them to the Project Manager. The Department has 20 working days for review. Delays beyond this time will extend the contract time day for day for the number of working days beyond the 20 days.

556.03.19 Bearing and Anchorage. Place masonry bearing plates on bearing areas that meet specifications. Install bearing plates level to provide an even bearing on the masonry.

Place masonry bearing plates on fiber-reinforced pads, that project a minimum of ½-inch (13 mm) on all sides of the bearing plates.

Make allowances for bottom chord elongation due to dead load when setting shoes or bearing plates for steel truss spans.

Install bridge rocker shoes to be vertical under full dead load at 60 °F (15 °C). Raise spans and make adjustments if the rockers are not correctly positioned with the final dead load on spans.

Construct concrete surfaces receiving elastomeric pads to compensate for bearing pad compression. Finish the bearing area with a wood float to a level plane. The surface must not vary by more than 1/16-inch (2 mm) from a straightedge placed in any direction across the area. Extend the bearing area at

least 1-inch (25 mm) beyond the elastomeric bearing pad dimensions. The finished elevation of the bearing surface must not vary by more than 1/8-inch (3 mm) from the specified beam-seat elevation unless otherwise approved.

556.03.20 Placing Anchor Bolts. Place anchor bolts meeting Subsection 552.03.14 requirements.

556.03.21 Straightening Bent Material. Straighten bent plates, angles or other shapes without damaging the material. The metal may be heated if approved. Do not exceed 1000 °F (537 °C). Once heated, cool the metal slowly.

All straightened metal will be inspected for defects.

556.03.22 Pin Connections. Furnish the Project Manager the pilot and driving nuts provided with the steelwork once the work is complete. The members must take full bearing on the pins. Bring pin nuts up tight, and burr the threads at the nut face.

556.03.23 Misfits. Correct all misfits, errors, and injuries as a part of the assembly and erection work. Report to the Project Manager all shop work errors that prevent the assembly and fitting of parts with a minimum use of drift pins, reaming, slight chipping or cutting. Obtain Department approval for the correction method. Corrections must be inspected and approved.

556.03.24 Cleanup. Remove all falsework, excavated or unused materials, rubbish, and temporary buildings. Restore all public and private property damaged during construction to its original condition.

Pull, cut off or otherwise remove all falsework piling 1 foot (305 mm) below finished the ground line or streambed, unless otherwise directed. Perform all work affecting the stream channel meeting the applicable requirements of Subsection 208.03.4 before final acceptance.

556.03.25 Rejections. An inspectors acceptance of material or finished members does not prevent later rejection if defects are found. Replace or repair rejected material and work at Contractor expense.

556.04 METHOD OF MEASUREMENT.

556.04.1 Lump Sum Basis. No measurement of structural steel quantities is made.

556.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Structural Steel	Lump Sum

The weight of structural steel in the Contract is an estimate only. No guarantee is made that the estimated weight is the correct weight to be furnished. No adjustment in the contract price is made if the weight furnished is more or less than the estimated weight.

If changes in the work ordered by the Project Manager vary the weight of steel to be furnished, the lump sum payment is adjusted as follows:

The value per pound (kilogram) of a decrease or increase in the weight of structural steel involved is determined by the following:

$$\textbf{Value per pound (kilogram)} = \frac{\textbf{Contract Lump Sum Bid}}{\textbf{Estimated Contract Weight}}$$

The adjusted contract lump sum amount paid is the contract lump sum bid plus or minus the value of steel involved in the change.

Should the ordered change materially alter the character of the work and the unit cost, compensation for that work is made at an agreed price established before the work is performed. Detail, in writing, the changes in procedures and the resulting costs for labor, equipment, and materials to support the agreed price.

The following percentages of the total quantity of structural steel in place are allowed for payment on progress estimates:

1. 90 percent when erected;
2. 97 percent when bolted and spot painted;
3. 100 percent when painted in compliance with the plans and specifications.

Payment at the Contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 557
STEEL BRIDGE RAILING

557.01 DESCRIPTION. This work is the furnishing and installing of steel bridge railing.

557.02 MATERIALS. Furnish materials meeting the following Subsection requirements:

Structural Steel Tubing	711.03
High Tensile Strength Anchor Bolts	711.06
Galvanized Metal	711.08
Structural Steel	711.02
Steel Beam Guardrail and Wood Blocks	705.01
Fiber-Reinforced Pads for Rail Post Base Plates	711.16

557.03 CONSTRUCTION REQUIREMENTS.

557.03.1 Fabrication Drawings. Furnish fabrication drawings for steel bridge railing meeting Subsection 556.03.2 requirements.

557.03.2 Fabrication. Fabricate steel bridge railing meeting the applicable requirements of Section 556.

557.03.3 Erection. Construct steel bridge railing as shown on the plans. Adjust the completed railing to compensate for any unevenness in the structure. Assure all rail posts are vertical. Do not place railing on a span until centering or falsework is removed. Place rail post base plates on fiber-reinforced pads, sized and positioned to project a minimum ½-inch (13 mm) on all sides of the base plates.

557.03.4 Painting. Clean and paint steel bridge railing specified to be painted meeting Section 612 requirements.

557.04 METHOD OF MEASUREMENT. Steel bridge railing of the type or types specified are measured by the linear foot (meter). Measurement is based on the computed horizontal distance between the centerlines of end base plates.

557.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Bridge Railing	Linear Foot (linear meter)

The following percentages of the total linear feet (meter) of steel bridge railing in place are allowed for payment on progress estimates:

1. 90 percent when erected;
2. 95 percent when bolted and spot painted;
3. 100 percent when painted in compliance with the Contract.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 558
TIMBER STRUCTURES

558.01 DESCRIPTION. This work is furnishing materials for, and constructing timber structures and the timber portions of composite structures.

558.02 MATERIALS. Furnish materials meeting the following Subsections requirements:

Treated and Untreated Timber Piles	706.05
Structural Timber and Lumber	706.01
Treated Timber	706.04
Bolts and Nuts	711.07
Galvanized Metal	711.08
Structural Steel	711.02
Crushed Top Surfacing	701.02

Drift-pins and dowels may be wrought iron or medium steel.

Furnish washers made of iron castings or malleable castings, unless otherwise specified.

Furnish galvanized or cadmium plated hardware, except cast iron washers, meeting ASTM A 165, Type OS.

558.03 CONSTRUCTION REQUIREMENTS.

558.03.1 Construction Drawings. Furnish shop drawings that detail the material grade, cutting, framing, boring details, dimensions, size of material, and all other information necessary for fabrication and erection of the timber.

Furnish all shop drawings on 22 X 36-inch paper (A1 paper) with a 1½-inch (46 mm) margin on the left side and a ½-inch (43 mm) margin on the other 3 sides.

Check and approve fabrication drawings before submitting 4 copies to the Project Manager. The Contractor approval must be shown on the drawings. Do not begin cutting and framing until the drawings are returned by the Project Manager.

558.03.2 Handling of Materials. Handle timber without dropping, breaking outer fibers, bruising, or penetrating the timber surface. Use rope slings to handle treated timber.

558.03.3 Storage of Materials. Store timber in neat stacks on ground free of weeds and rubbish.

Open-stack untreated timber at least 12-inches (300 mm) above the ground. Cover timbers as required to protect them from weather. Close-stack treated timbers to prevent warping.

558.03.4 Treatment of Breaks and New Cuts. Trim and treat all cuts and abrasions in treated timbers with 3 applications of a solution of copper naphthenate containing a minimum of 2% copper metal or with chromated copper arsenate (CCA) meeting AWPA M4. Follow treatment with one coat of hot tar.

558.03.5 Temporary Attachment. Attach forms or temporary braces to treated timber with nails or spikes. Once the nails or spikes are removed, fill the holes by driving galvanized nails or spikes flush with the surface or plugging with creosote plugs after treating the holes with creosote oil.

558.03.6 Bearing. Level post and pile caps to provide full, even bearing on all posts or piles in the bent. Secure caps to each pile or post using a 3/4-inch (19 mm) diameter drift-pin extending at least 9-inches (230 mm) into the pile or post center.

558.03.7 Sills and Mud Sills. Evenly bed mud sills to solid bearing and tamp in place. Assure sills have true and even bearing on concrete sills, piles, or pedestals. Drift-bolt sills to mud sills or piles with 3/4-inch (19 mm) diameter bolts or larger extending into the concrete sills or piles at least 6-inches (155 mm). Remove all soil in contact with sills to provide free air circulation.

558.03.8 Framing. Cut timber for framing before treating with preservatives.

Cut and frame truss and bent timbers to a close fit providing even bearing over the entire joint contact surface. Blocking, shimming or open joints are not allowed.

Construct mortises true to size for the full depth. Fit tenons snugly in mortises.

Accurately frame cross bridging between stringers at the center of span and securely toe-nail with at least 2 nails in each end. Assure all cross bridging members have full bearing at each end against the sides of stringers.

558.03.9 Bolt Holes. Size holes for drift-pins, dowels, and bolts the same diameter of the pin or dowel to be used. Do not make holes for lag screws larger than the body of the screw at the base of the thread. Make holes for rods 1/16-inch (2 mm) larger in diameter than the rod.

Treat all bore holes in treated timber, made after treatment, with an approved pressure bolt hole treater. Seal holes for rods with hot tar or other approved waterproofing once the rods are inserted.

Countersink where smooth faces are specified. Treat horizontal recesses formed for countersinking with 3 applications of copper naphthenate containing a minimum of 2 percent copper metal or with chromated copper arsenate (CCA) meeting AWPA M4. Fill the countersink with hot tar once the bolt or screw is in place.

558.03.10 Stringer Sizing. Size stringers between bearing points only. Make butt joints for outside stringers. Frame interior stringers to bear over the full width of floor beam or cap at each end. Securely anchor the stringer ends to the cap. Separate untreated timbers at least ½-inch (13 mm) for air circulation.

558.03.11 Roadway Floors. Make roadway floors strip or laminated as specified, surfaced S1S1E or S4S.

A. Laminated Floors. Place the strips on edge and draw down tightly against the stringer or nailing strip and the adjacent strip and spike them. Extend each strip the full deck width unless otherwise specified.

Spike each strip to the adjacent strip at intervals not exceeding 2 feet (610 mm), staggering the spikes 8-inches (205 mm) in adjacent strips. Use spikes long enough to pass through 2½ strips. Toe-nail each strip to alternate stringers with 40d (125 mm X 5.7 mm) common nails with adjacent strips nailed to every alternate stringer unless bolting is specified. Toe-nail the ends of all strips to the outside stringer. Cut off the strip ends on a true line parallel to the centerline of the roadway. When bolts are used to fasten laminated floors to stringers, space the bolts as specified and draw them down tightly on the bolting strips. Draw the bolt heads down flush with the deck surface. Use double nuts or single nuts with lock washers on all bolts. Spike the strips as specified above.

B. **Plank Floors.** Make plank floors out of a single thickness of plank on stringers or joists. Unless otherwise specified, lay the planks heart side down. Spike planks to each joist or nailing strip with at least 2 spikes 4-inches (100 mm) longer than the plank thickness. Spike the planks at least 2½-inches (64 mm) from the edges with the edges cut off on a straight line parallel to the roadway centerline. Adjacent planks must not vary in thickness by more than 1/16-inch (2 mm). Planks are S1S1E unless otherwise specified.

558.03.12 Deck Surface Treatment. Treat the entire top surface of the deck and the inside surfaces of curbs with hot tar meeting ASTM D 490, Grade RT-7 or RT-8 (RT-7 is adapted to cold-weather application, RT-8 to warm-weather application).

Heat the tar in an open tank or kettle to between 200 °F to 225 °F (93 °C to 107 °C). Apply 3 even coats to the surfaces to be treated, each at 1/4 gallon per square yard (1.1 L per m^2). Allow each coat sufficient time to cool and set up before applying the next coat.

After the final coat of tar has cooled and set up, cover the entire deck surface with aggregate surfacing at 1 cubic yard per 24 square yards (1 m^3 per 25 m^2) of surface area before opening to traffic. Furnish aggregate surfacing meeting the requirements of crushed top surfacing Type A, Grade 2 or 3, or Type B, Grade 3, except that the material passing the 200-mesh (0.075 mm) sieve cannot exceed 10% .

558.03.13 Wheel Guards. Bolt wheel guards to the outside stringers using 3/4-inch (19 mm) machine or hook bolts spaced a maximum 5 feet (1525 mm) center-to-center. Lap all joints. A bolts must pass through each lapped joint.

Provide drain holes as specified. Line the drain holes with galvanized iron lining, positioned to discharge free of the structure.

558.03.14 VACANT.

558.03.15 Nailing. Drill holes for nails that are driven near timber ends. Drill the hole only in the piece to be attached. Drill the hole smaller than the nail to provide a tight fit.

558.03.16 Washers. Use washers behind all bolt heads and nuts. Place washers for carriage bolts and large-head timber bolts under the nuts only.

Use cast-washers of the thickness equal to the bolt diameter and a diameter 4 times the thickness. Use malleable and plate washers with a thickness equal to one-half the diameter of the bolt, and the length of each side equal to 4 times the bolt diameter.

Use cast iron washers when timber is in contact with earth.

558.03.17 Treating and Painting Untreated Timbers. Treat the following surfaces with 3 applications of copper naphthenate containing a minimum of 2% copper metal or with chromated copper arsenate (CCA) meeting AWPA M4:

1. Ends, tops, and all post contact surfaces, sills, caps, floor beams, and stringers;
2. Ends, joints, and contact surfaces of bracing and truss members;
3. Timber bumper surfaces;
4. The back face of bulkheads;
5. All other untreated timber that is in contact with earth.

558.04 METHOD OF MEASUREMENT. Treated and untreated timber and lumber is measured by the thousand feet board measure (cubic meter) based on nominal actual thicknesses and widths. Measurements are computed using the plan dimensions unless changes in plan dimensions are approved by the Engineer. The actual lengths (volume) of the individual pieces in the finished structure will be measured, without deductions for daps, cuts, or splices.

The measurement of laminated timber decking is based on the number of pieces of the size or sizes specified, after dressing, and the actual lengths used in the structure.

Measurements consist of only timber that is a part of the completed and accepted work and does not include timber used for erection, such as falsework, forms, bracing, and sheeting.

558.05 BASIS OF PAYMENT. Payment for the completed and accepted work is made under the following:

Pay Item	Pay Unit
Treated and Un-treated Timber	Thousand Board Foot (cubic meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 559
PILING

559.01 DESCRIPTION. This work is the furnishing and placing of timber, steel, concrete, and other pile types.

559.02 MATERIALS. Furnish materials meeting the following Section and Subsection requirements:

Treated and Untreated Timber Piles	706.05
Structural Steel Piles	711.10.1
Steel Pipe Piles	711.10.2
Precast Concrete Piles	Sections 551 and 552
Precast Prestressed Concrete Piles	Sections 551 and 553

Fill steel pipe piles with concrete.
Furnish pile shoes meeting the Contract requirements.

559.03 CONSTRUCTION REQUIREMENTS.

559.03.1 Test Piles. Drive test piles at the Contract locations or as directed.

Add to the test piles, the length shown on the plans below the cutoff elevation. Furnish the additional pile length to reach from the cutoff elevation to the pile position in the driving equipment. Increase the length at least 2 feet (600 mm) for timber piles and 1 foot (300 mm) for steel and concrete piles.

Use undamaged test piles as service piles in the completed structure. Excavate the ground at each test pile to plan grade before driving the pile. Drive test piles as specified in one continuous operation to practical refusal using the same equipment used to drive the service piles.

559.03.2 Load Tests. Perform load tests on test piles as specified.

559.03.3 Furnishing Piles. Once the test piles are driven, order piles using the Project Manager furnished order list. The list will designate the number, type, and length of piles required.

The listed lengths are those required below cutoff. Adjust the lengths for difference between cut off length and pile position in driving equipment. Increase timber pile length at least 2 feet (600 mm), and 1 foot (300 mm) for other piles. Remove and dispose of the excess length after driving.

Furnish all timber piling from the Project Manager's order list, meeting the requirements of Table 559-1.

559.03.4 Driving Piles - General. Drive all piles furnished under Subsection 559.03.3 to the depth set below cutoff or as directed.

Contract pile bearing requirements are based on design loadings and indicate the loads that the piles are to support. Pile bearings computed using the formulas in Subsection 559.03.5 are approximations only.

Drive each service pile in one continuous operation. Repair equipment break downs as soon as practical.

TABLE 559-1
DIMENSIONAL REQUIREMENTS OF TIMBER PILES[1]

Length (ft) (m)	Diameter (Approx.)			Circumference		
	3 Ft (900 mm) From Butt		At Tip	3 Ft (900 mm) From Butt		At Tip
	Min	Max	Min	Min	Max	Min
	14-Inch (350 mm) Diameter Piles					
Under 40 12.2 m	14 350 mm	18 455 mm	9 230 mm	44 1120 mm	57 450 mm	28 710 mm
40 to 54 12.2 m 16.5 m	14 350 mm	18 455 mm	9 230 mm	44 1120 mm	57 1450 mm	28 710 mm
55 to 74 16.8 m 22.6 m	14 350 mm	18 455 mm	8 200 mm	44 1120 mm	57 1450 mm	25 635 mm
75 to 90 22.9 m 27.5 m	14 350 mm	20 510 mm	7 180 mm	44 1120 mm	63 1600 mm	22 560 mm
Over 90[2] 27.5 m	—	—	—	—	—	—
12-Inch (300 mm) Diameter Piles						
Under 40 12.2 m	12 300 mm	20 510 mm	8 200 mm	38 965 mm	63 1600 mm	25 635 mm
40 to 54 12.2 m 16.5 m	12 300 mm	20 510 mm	7 180 mm	38 965 mm	63 1600 mm	22 560 mm
55 to 74 16.8 m 22.6 m	13 330 mm	20 510 mm	7 180 mm	41 1040 mm	63 1600 mm	22 560 mm
75 to 90 22.9 m 27.5 m	13 330 mm	20 510 mm	6 150 mm	41 1040 mm	63 1600 mm	19 485 mm
Over 90[2] 27.5 m	—	—	—	—	—	—

NOTE:
[1] Douglas fir, Hemlock, Larch, Pine, Spruce, or Tamarack
[2] Dimensions of piles over 90 ft. (27.5 m) in length are specified in the Contract.

Minimum pile penetrations are as follows:

1. Footings in natural ground 10 feet (3 m) below bottom of footing elevation;
2. Footings in embankments 10 feet (3 m) below natural ground.

The Project Manager may change the pile penetrations.

If piling cannot be driven to the required penetration using the pile hammer alone, hard-driving procedures may be required, or a lesser penetration may be accepted.

Locate piles as shown on the plans. The allowable tolerance from a plumb line is 1/4-inch (20 mm) per foot (1000 mm) of pile length. No additional compensation is allowed for re-driving to meet the tolerance.

Safe bearing values will be based on data gathered during driving operations. Soil characteristics, penetration, driving conditions, distribution, size, length, and weight of piles will be used to determine safe bearing values. The safe bearing values will not be less than the design loads specified, unless authorized.

When the bearing values cannot be obtained, stop the driving when the pile is approximately 2 feet (610 mm) above cutoff elevation. Allow the pile to setup for between 24 and 72 hours. Resume driving and calculate bearing values for each blow up to 5 blows. Drive the piles to a sound cutoff elevation.

559.03.5 Driving Timber Piles. Drive treated and un-treated timber piles using a steam, air, or a diesel hammer developing a minimum 12,000 ft-lb (16 kN-m) of energy per blow.

The following formulas determine the bearing values when piles are not driven to practical refusal:

For single-acting steam hammers, air hammers, and diesel hammers:

(English)

$$P = \frac{2WH}{S + 0.1}$$

(Metric)

$$P = \frac{.05\,WH}{.305\,S + .00076}$$

For double-acting steam hammers and air hammers:

(English)

$$P = \frac{2H(W + Ap)}{S + 0.1}$$

(Metric)

$$P = \frac{.05\,H\,(W + Ap)}{.3055 + .00076}$$

Where:

- **P** = safe load per pile in pounds (N)
- **W** = weight in pounds (N) of striking part of hammer
- **H** = height of fall in feet (m)
- **A** = area of piston in square inches (mm^2)
- **p** = steam or air pressure in pounds per square inch (Pa) at hammer
- **S** = the average penetration in inches (m) per blow for the last 10 to 20 blows of the hammer

The variable **WH** is determined by the Department.

These formulas apply only when:

a. The hammer is operating normally;
b. The penetration is at a uniform rate;
c. The pile head is not broomed or crushed;
d. Followers are not used.

559.03.6 Driving Steel Piles. Drive steel H-piles and steel pipe piles using steam, air, or diesel hammers that develop a minimum 12,000 ft-lb (16 kN-m) of energy per blow. Drive piles to the specified depth, or as directed.

The safe bearing values for steel piles, not driven to the specified depth, may be approximated by the formulas specified for timber piles.

559.03.7 Driving Precast Concrete and Prestressed Precast Concrete Piles. Drive pre-cast concrete and pre-stressed pre-cast concrete piles using steam, air, or diesel hammers that develop 1 ft-lb (1.36 kN-m) of energy per blow for each pound (kilogram) of weight driven, but not less than 12,000 ft-lb (16 kN-m) of energy per blow unless otherwise directed. Drive all concrete piles to the specified depth, or as directed.

The safe bearing values for concrete piles may be approximated by the formulas specified for timber piles.

559.03.8 Inspection of Piles.

A. Untreated Timber Piles. Untreated timber piles will be inspected at the project.

B. Treated Timber Piles. Treated timber piles will be inspected for grade and condition at the treating plant before treatment by a certified Inspector. The Inspector will stamp each pile on the butt end leaving an impression, legible after treatment. The stamp will be copyrighted by the Inspector, and the impression filed with the Department.

The piles will be inspected again after treatment. The Inspector will stamp each pile on the butt end with a stamp differing from that used before treatment. This impression must also be filed with the Department.

The Inspector will prepare an itemized report of the pile inspection. The report will document treatment temperatures, quantity of preservative, time of treatment, lengths and sizes, total footage, and all other pertinent information.

Treated timber piles not stamped before and after treatment cannot be used in the work.

C. Steel Piles. Steel piles may be inspected at the rolling mill and will be inspected at the project.

Furnish 2 copies of the certified mill test reports showing the chemical and physical test results for each heat number of steel piles in the shipment.

Camber and sweep of steel piles must not exceed that calculated by the following formula:

$$\text{Maximum Camber or Sweep, In} = \frac{\text{1/8 in (3.2 mm) x pile length, ft (305 mm)}}{\text{10 ft (3.05 m)}}$$

Damaged or bent piles will be rejected.

D. **Concrete Piles.** Concrete piles will be inspected at the fabricating plant and at the project.

559.03.9 Excavation. Complete excavation before driving piles.

Remove material forced up between piles to the plan elevation at Contractor expense before placing foundation concrete.

559.03.10 Caps. Protect the heads of all concrete and timber piles with caps.

Follow the pile manufacturer's recommendations regarding driving heads, mandrels, or other required devices.

Cut steel piling heads squarely and provide a driving cap. Hold the pile axis in line with the axis of the hammer.

559.03.11 Collars. Provide collars, bands, or other devices when required.

559.03.12 Pointing. Point timber piles when required.

559.03.13 Metal Shoes. Provide piles with metal shoes when required.

559.03.14 Splicing Piles. Use full-length piles where practical.

Perform welding meeting the contract requirements for splicing steel piles or shells.

559.03.15 Hard-Driving Procedures. Hard driving is sustained driving beyond practical refusal to the point that pile damage is likely and imminent, and requires methods other than the pile hammer to obtain required penetration in natural ground.

The Project Manager will determine practical refusal, considering the type and size of piling, soil conditions, and the type and size of the pile hammer. Practical refusal is a penetration of 1 to ½-inch (25 to 10 mm) per 10 blows for wood piles and from 3/4 to 1/4-inch (20 to 5 mm) per 10 blows for steel piles.

Sustained driving is driving for more than 2 feet (600 mm) of penetration at blow counts in excess of those stated above.

Use hard driving procedures when directed. These procedures may include the use of pile shoes and pile reinforcement, drilling and shooting, pre-boring, jetting, punching, or using a different type or size of pile hammer, to reach the specified penetration without pile damage.

559.03.16 Alignment. Maintain pile alignment during pile driving. The Project Manager will suspend driving should the pile alignment fluctuate during driving.

559.03.17 Followers. Use followers only with the Project Manager's written permission. When requesting to use a follower, include detailed drawings of the proposed equipment. If a follower is used, drive one pile from each group of 10 as a long test pile, driven without a follower.

559.03.18 Special Pile Driving Methods. Request permission to use water jetting, pre-bore, or other special pile driving methods at least 2 working days before pile driving is to begin. Detail in the request the equipment and its use in the work. Assume all cost associated with special pile driving.

Pre-bore, when specified, is measured and paid for separately.

559.03.19 Defective Piles. Drive piles without crushing or spalling the concrete piles, splitting, splintering, or brooming wood piles, or deforming steel piles. Repair or replace all piles damaged during driving at Contractor expense.

Concrete pile with visible cracks or defects that may affect the strength or life of the pile will be rejected.

559.03.20 Storage and Handling of Timber Piles. Store and handle treated piles to prevent breaking or damaging the surface. Do not use cant hooks, dogs, or pike poles.

Treat surface cuts or breaks on treated piling and all bolt holes with 3 applications of copper naphthenate containing a minimum of 2% copper metal or with chromated copper arsenate (CCA) under AWPA M4.

559.03.21 Cutting Off Timber Piles. Saw the tops of all timber piles to the elevation provided by the Project Manager. Saw piles supporting timber caps or grillage to match the bottom plane of the superimposed structure. Provide the pile length above the cutoff elevation to permit the complete removal of all material injured by driving. Remove the damaged material from piles driven close to the cutoff elevation.

Treat the cut heads of all treated timber piles with 3 applications of a solution of copper naphthenate containing a minimum of 2% copper metal or with chromated copper arsenate (CCA) following AWPA M4.

Dispose of all pile cutoffs.

559.03.22 Cutting Off Steel or Steel Pipe Piles. Cut piles off at the required elevation. If capping is required, make the connection as specified.

Dispose of all pile cutoffs.

559.03.23 Cutting Off Precast Concrete and Precast Prestressed Concrete Piles. Cut off precast concrete and precast prestressed concrete piles at the required elevations. Cap, if required, as specified in the Contract.

Dispose of all concrete pile cutoffs.

559.03.24 Piles Cast in Place and Steel Pipe Piles. Construct cast-in-place piles as specified.

Fill steel pipe piles with the specified class of concrete.

Provide lights for inspecting concrete placement in the steel pipe piles. Provide lighting to illuminate the full pile length.

Correct or replace all improperly driven, broken, or otherwise defective piles at Contractor expense.

Remove all water in steel pipe piling before placing concrete.

Do not drive pile within a 15 feet (4.5 m) radius of the concrete work or begin pile driving until all the piling for any one bent has been completely driven. Resume driving in the above areas after the concrete in the last pour has set at least 7 days.

559.03.25 Extensions or Build-Ups. Make extensions, splices, or build-ups on precast concrete or precast prestressed concrete piles as follows:

Once driving is completed, remove the concrete pile end, leaving the pile reinforcing steel exposed for a length of 40 diameters. Finish cut the pile top normal to the pile axis. Splice reinforcing steel matching that in the pile to the projecting pile steel and place the form work.

Use the same concrete mix design for the pile top as used in the pile. Thoroughly wet and coat the pile top with a thin coating of neat cement or other approved bonding material before placing concrete. Leave the forms in place at least 7 days. Finish the extension surface to match the original pile.

Construct steel pile extensions by splicing on additional sections of steel piling. Make splices as specified or directed.

559.03.26 Painting Steel Piles and Steel Pile Shells. Paint piles starting 2 feet (600 mm) below the water level or ground surface to the top of the exposed steel.

A. Paint. Furnish paint meeting Subsection 710.02 (B)(4) requirements.

B. Surface Preparation. Prepare the pipe pile surface to be painted following the paint manufacturer's recommendation's.

C. Painting. Follow all the paint manufacturer's recommendations for paint application. Shop apply the first 2 paint coats for the pipe pile to produce a minimum 12 mil (300 μm) dry film thickness. Do not paint over pile markings for certification until they are inspected against the certifications. Provide a painter's certification that the paint was applied following the manufacturer's recommendations and certified test results showing the coating thickness on the piles.

Repair coating damage due to transport and handling in the field following the paint manufacturer's recommendations before applying the finish coat.

Use the same paint or a paint compatible with the first 2 paint coats as a finish coat. Paint the finish coat providing a minimum 4 mils (75 μm) dry film thickness from the groundline to the point the pile is embedded in concrete. The Project Manager will select the finish coat color.

559.04 METHOD OF MEASUREMENT.

559.04.1 Test Piles. Test piles are lump sum. Base the lump sum bid price on the test pile quantity specified in the Contract. If the quantity is increased or decreased during construction, the lump sum bid price will be increased or decreased using the following formula:

$$\text{Dollar Amount of Increase or Decrease in Lump Sum Bid Price} = (a \times c) + (b \times d)$$

Where: **a** = Length of test pile required below cutoff elevation, ft (meter)
b = "**a**" minus footing embedment, ft (meter)
c = Unit price bid for furnishing piling, $ per linear foot (meter)
d = Unit price bid for driving piling, $ per linear foot (meter)

559.04.2 Load Tests. Load tests are measured by each completed and accepted test made.

559.04.3 Furnishing Piles. Furnished piles are measured in linear feet (meters) computed from the Project Manager's order list, as specified in Subsection 559.03.3. If an order list is not furnished, the measured quantity is the total linear feet (meter) of piling driven, measured to the nearest foot (305 mm). The required pile length increase between cut-off and position in driving equipment furnished under Subsection 559.03.3, is not measured for payment.

559.04.4 Driving Piles. Driving pile are measured by the linear feet (meter) of piling driven below the bottom of the substructure units or below the bottom of pre-bore holes when pre-boring is required. Driving is measured to the nearest foot (305 mm).

559.04.5 Pre-boring Holes for Piles. Pre-boring holes are measured by the linear feet (meter) drilled below the bottom of the substructure units. Pre-boring is measured to the nearest foot (305 mm).

559.04.6 Pile Splices. Pile splices are measured as the number of pile splices specified in the Contract.

Splicing permitted for Contractor convenience to meet order list lengths, to suit driving conditions, or for other reasons is not measured.

559.04.7 Pile Shoes. Pile shoes are measured as the total number specified in the Contract or authorized by the Project Manager.

559.04.8 Extensions or Build-ups. Extensions or build-ups are measured by the total linear feet (meter) specified in the Contract or ordered in writing by the Project Manager.

Measurement is to the nearest foot (305 mm).

559.04.9 Filler Concrete. Filler concrete is measured by the cubic yard (cubic meter).

559.04.10 Piles. Piles are measured by the piles furnished and placed when the Contract specifies payment to be made on a per each basis.

559.04.11 Hard Driving. Hard driving is measured for payment by the linear feet (meter) of piling driven into natural ground using hard-driving procedures described in Subsection 559.03.15. Hard driving is measured to the nearest foot (305 mm).

Penetration of hard layers 2 feet (610 mm) or less in thickness using the pile hammer alone is not measured as hard driving but is measured under Subsection 559.04.4.

559.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Test Piles	Lump Sum
Load Test	Each
Furnishing Piles	Linear Foot (meter)
Driving Piles	Linear Foot (meter)
Pre-bore Holes	Linear Foot (meter)
Pile Splices	Each
Pile Shoes	Each
Extensions/Buildups	Linear Foot (meter)
Filler Concrete	Cubic Yard (cubic meter)
Hard Driving	Linear Foot (meter) or Force Account

559.05.01 Falsework and Defective Piles. No payment is made for furnishing or driving falsework piles, piles driven out of place, defective piles, or piles that are damaged in handling or driving.

559.05.02 Additional Requirements. Brackets, plates, or other reinforcement on steel piles required by the Project Manager in addition to that in the Contract is paid for as extra work.

No separate payment is made for painting exposed portions of steel piles or steel pile shells.

559.05.03 Piles Ordered and Not Driven. Piles purchased on the Project Manager's itemized list but not incorporated in the finished structure are paid at invoice prices. Deliver to the location designated by the Project Manager.

559.05.04 Progress Payments. The following percentages of the total quantity of piles driven are allowed for payment on progress estimates:

1. 95 percent when driven to final penetration;
2. 100 percent when cut off in compliance with the Contract.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 601
METAL WATER SERVICE LINES

601.01 DESCRIPTION. This work is constructing steel and copper water service lines, ½-inch (13 mm) through 2-inch (50 mm) nominal diameter.

601.02 MATERIALS. Furnish materials meeting the following Subsection requirements:

Seamless Steel Pipe 709.09
Copper Pipe 709.10

601.03 CONSTRUCTION REQUIREMENTS. Install water service lines, make all connections, and pressure test the system meeting the requirements of the Montana Public Works Standard Specifications, and the Contract.

Meet the requirements of Section 207 for trench excavation, foundation preparation, and backfilling.

601.04 METHOD OF MEASUREMENT. Water service lines are measured by the linear foot (meter).

Excavation is measured by the cubic yard (cubic meter) under Subsection 207.04.

601.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Water Service Line	Linear Foot (meter)
Excavation	Cubic Yard (cubic meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 602
REMOVE AND RELAY PIPE CULVERT

602.01 DESCRIPTION. This work is removing pipe culverts from the specified locations, salvaging and storing, disposing of, or cleaning and re-laying the removed pipe.

602.02 MATERIALS. Replacement pipe for existing pipe not re-usable is specified in the Contract.

602.03 CONSTRUCTION REQUIREMENTS.

602.03.1 Culvert Removal. Remove pipe culverts without damaging the pipe. Replace pipe that is damaged by removal with equal lengths of pipe, at Contractor expense. The replacement pipe must be the same type and diameter and in equal or better condition than the removed pipe before it was damaged.

Store removed pipe at the specified locations.

Backfill pipe removal locations within the new roadway template section meeting Subsections 203.03.2 and 203.03.3 applicable requirements.

602.03.2 Relaying Culverts. Clean out pipe to be re-laid of dirt, rubbish, and other materials and relay meeting Section 603 requirements.

602.03.3 Restoration and Maintenance of Existing Pavement. Restore and maintain existing pavement structures disturbed during the removal or relaying of pipe culverts meeting Subsection 603.03.5 requirements.

602.04 METHOD OF MEASUREMENT.

602.04.1 Remove Pipe Culverts. Pipe culvert removal is measured by the linear foot (meter) of pipe or the cubic yard (cubic meter) of culvert excavation.

When payment is by the linear foot (meter), the culvert excavation for removing the pipe is not measured for payment.

Measurement for removal by the linear foot (meter) is made along the flowline of the existing culvert for the portion(s) removed.

Measurement for removal by the cubic yard (cubic meter) of culvert excavation is made from the existing surface profile to the bottom of the culvert plane as specified in Subsection 207.04.

Pipe removal is not measured separately.

604.02.2 Relay Pipe Culverts. Relay pipe culvert is measured by the linear foot (meter) along the flowline of the re-laid lengths.

Culvert excavation for relay pipe culverts is measured by the cubic yard (cubic meter) under Subsection 207.04.

602.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Remove Pipe Culvert	Linear Foot (meter) or Cubic Yard (cubic meter)
Relay Pipe Culvert	Linear Foot (meter)
Culvert Excavation	Cubic Yard (cubic meter)

Payment at the Contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 603
CULVERTS, STORM DRAINS, SANITARY SEWERS, STOCKPASSES, AND UNDERPASSES

603.01 DESCRIPTION. This work is furnishing and installing culverts, storm drains, sanitary sewers, stockpasses, underpasses, further referred to as pipe.

603.02 MATERIALS. Furnish materials meeting the following Subsection requirements:

Culvert Sealers	707.02
Reinforced Concrete Pipe	708.01
Concrete Pressure Pipe	708.02
PVC Sewer and Drain Pipe	708.05
PVC Water Pipe	708.06
Polyethylene Corrugated Drainage Pipe or Tubing	708.07
Ductile Iron and Steel Water Pipe	709.01
Corrugated Steel Pipe and Pipe Arches.	709.02
Steel Structural Plate Pipe and Pipe Arches	709.03
Bituminous Coated Corrugated Steel Pipe, Pipe Arches, Steel Structural Plate Pipe and Pipe Arches	709.04
Pre-coated, Galvanized Steel Culverts and Underdrains	709.05
Corrugated Steel Pipe for Underdrains	709.06
Corrugated Aluminum Pipe and Pipe Arch Culverts	709.07
Corrugated Aluminum Pipe for Underdrains	709.08
Seamless Steel Pipe	709.09
Slotted Corrugated Steel Pipe	709.11

Materials will be acceptance inspected at the manufacturing source.

603.03 CONSTRUCTION REQUIREMENTS.

603.03.1 General. The locations and pipe lengths shown in the Contract are an estimate only and may be revised. Order pipe using only the Project Manager furnished list of sizes and lengths.

Repair or replace pipe damaged during delivery, storage, or placing at Contractor expense.

When the Contract allows optional types of pipe material for culverts at specific locations, any of the material types shown in the Contract may be used for that installation.

Provide the Project Manager in writing, at the Preconstruction conference, a list of proposed materials for use at each location optional material is allowed.

The type and quantity of material for bidding is listed in the Contract in columns under the heading "Basic Bid Items". The information in these columns is what would be required to complete the planned installation using the Basic Bid Pipe,

which is concrete, when it is an option. If concrete is not an option, steel pipe is the basic bid pipe. Include terminal sections, where required.

Each pipe size is paid for at the unit price bid and is full compensation for the pipe regardless of the pipe optioned by the Contractor. Only work shown in the "Basic Bid Items" columns on the plans is paid for at a given installation, and the quantities are based on measurements for the basic pipe. Additional work that is required due to field conditions and not associated with the selected pipe is measured and paid for on quantity changes that would result if the basic bid pipe been installed. All pay items are measured and paid for based on the basic bid pipe in the Contract.

Strut pipe arches if specified in the Contract.

603.03.2 Excavation and Foundation Preparation. Excavate and prepare the pipe foundation as specified in Section 207.

Place bedding material meeting Section 207 requirements and the Detailed Drawings.

603.03.3 Installation.

A. Prefabricated Non-metal Pipe. Lay non-metal pipe on the foundation in standard lengths starting at the outlet end, with the groove or bell ends upgrade. Recess the bell ends into the foundation.

Join the pipe ends to form a positive, tight-fitting joint by applying uniform pressure along the entire circumferential ends of the sections. Place pipe using methods that prevent pipe damage. Replace pipe damaged during placing at Contractor expense.

Make the joints watertight for round concrete pipe, used for irrigation, storm drainage, or sanitary sewage, or other purposes subject to continuous flow, sealing them with rubber gaskets meeting Subsection 707.02.1. Use flexible plastic joint seal compound for concrete arch pipe joints that meet Subsection 707.02.2 requirements.

The culvert joints for normally dry installations may be sealed with rubber-type gaskets or an approved joint-sealing compound, except where open joints are specified.

Construct angles, turns, and branch connections using pre-fabricated sections or construct as shown in the Detail Drawings.

Construct pipe dead ends and branches using closed ends or stoppers of equal strength to the pipe wall, cemented to the pipe.

Flared end terminal sections used with concrete pipe may be precast standard sections or cast in place as shown in the Detail Drawings.

Cap one end of concrete pipe tee sections that connect to median inlets when specified. Use a pre-fabricated cap or construct a cap of reinforced concrete and connect to the tee section forming a watertight joint with a strength equal to the pipe wall strength.

Keep all trenches dry when placing pipe and until the joint filler has cured.

B. Prefabricated Corrugated Metal Pipe. Place the pipe on the foundation with each section approximately 1-inch (25 mm) apart. Follow the pipe manufacturer's instructions for connecting joints. Connect the sections with

bolted coupling bands shaped to fit the formed pipe. Tap the coupling bands with mallets as the bolts are tightened.

The difference in diameter of abutting pipe ends to be coupled must not exceed 1/2-inch (13 mm).

Do not damage the pipe coating.

Culverts for siphons are designated as "CSP Siphon or "CSP irrigation".

Construct field joints following the manufacturer's instructions for the type of pipe and coupling bands or devices used.

Construct the field joints for corrugated metal pipe to maintain the pipe alignment and prevent the fill material from infiltrating the joints. Provide circumferential and longitudinal strength using the structural joint performance criteria of Division 2, Section 23 of the AASHTO Standard Specifications for Highway Bridges. Assure the field joints for siphon and irrigation pipe installations are watertight and meet Subsection 709.02 requirements. Correct all installations not meeting any of these requirements at Contractor expense.

Conduct all required water-tightness tests on siphon and irrigation pipe installations using **MT-420** or an approved procedure.

Cap one end of steel and aluminum pipe tee sections that connect to median inlets. Use a metal cap of equal thickness to the pipe wall and attach it to the tee section forming a watertight joint of equal strength to the pipe wall strength.

Field coat aluminum or Type II aluminized pipe to be in contact with fresh concrete with an asphalt mastic meeting AASHTO M 243 requirements over the full surface to be in contact. The asphalt container's label must provide the following information:

a. Name of Product;
b. Specification;
c. Lot Number;
d. Date of Manufacture;
e. Quantity of Mastic in Container;
f. Manufacturer's Name and Address.

Separate aluminum pipe coupled to dissimilar metals by either a bituminous-coated coupling, polyvinyl sheeting, painted with rubber-base paints, or use aluminized steel.

C. Structural Plate Types. Follow the manufacturer's field erection recommendations and the Contract requirements. Do not start work until the Project Manager and Contractor have the manufacturer's specifications and instructions at the work site.

Do not place backfill until all plates in a ring are complete and all bolts in the structure are tightened to the manufacturer's specifications.

Compact backfill using hand-operated compaction equipment within 6 feet (1.8 m) of the pipe neat lines.

Tighten all bolts in the assembly to the pipe manufacturer's torque specifications.

Long-span structure requirements are specified in the Contract.

Match the existing pipe section extensions for existing steel structural plate pipe and pipe arch culverts and stockpasses. Remove beveled ends

on existing pipe, install the new pipe sections, and re-install or replace the beveled ends as specified.

Pipe end treatment and slopes are detailed in the Contract.

Replace damaged structural plates at Contractor expense.

D. **Ductile Iron Pipe.** Lay pipe to the specified line and grade, installing all appurtenances as specified. Uniformly support the pipe throughout its length, except at joints. Make depressions in the foundation for bells, couplings or other connectors at joints.

Bring the pipe to grade by working the material along the barrel of the pipe, leaving the joints un-supported. Flare, grind, file, or machine the pipe cut ends to make the connections. Prevent foreign material from entering the pipe during the work.

Do not deflect pipe beyond the manufacturer's allowable tolerances.

Inspect fittings for cracks, blowholes, chips, and coating damage before installation. Replace defective fittings.

Lower fittings into the trenches without damaging the inside lining or outside coating.

Install concrete thrust blocks against undisturbed soil.

Make pipe joint connections following the manufacturer's recommendations.

603.03.4 Backfilling.

A. **General.** Use backfill material free of sticks, sod, frozen soil, or other deleterious matter.

Do not permit stones, rocks, chunks of broken concrete, or other material larger than 3-inches (75 mm) within the top 2 feet (610 mm) of the top of water and sanitary sewer lines and within 1 foot (305 mm) of the pipe top for all other installations.

Replace the top 2 feet (610 mm) of backfill for excavations in existing roadway sections "in-kind".

Place backfill material in maximum 6-inch (155 mm) layers loose thickness and compact. Firmly tamp the backfill under the pipe haunches. Extend the backfill material placed above the excavation limits or the ground line beyond each side of the pipe equal to twice the pipe diameter or 12 feet (3.7 m), whichever is less.

Compact backfill equally on each side of the pipe to at least 1 foot (305 mm) above the pipe top.

Use equipment and methods for backfilling and compacting that do not distort, misalign, or damage the pipe. Replace pipe that is distorted, misaligned, or damaged at Contractor expense.

Do not allow heavy equipment to pass over any pipe until at least 4 feet (1.2 m) or one-half pipe diameter of backfill, whichever is greater, is placed and compacted over the pipe.

B. **Imperfect Trench Method.** Culvert installation using the imperfect trench method is shown in the Detail Drawings.

C. **Rock Embankment.** Install pipes placed in blasted or fractured rock embankments as follows: Envelope the exposed pipe surface above the level of the bedding trench with graded bedding material. Extend the

envelope to one-half the nominal pipe diameter or 3 feet (915 mm), whichever is greater. Completely surround the pipe with graded bedding material when a bedded trench is not specified.

Use graded bedding material meeting Subsection 701.04.1 requirements; placed and compacted meeting Subsection 603.03.4(A).

603.03.5 Restoration and Maintenance of Existing Pavement. Restore the existing pavement excavated for pipe installation using material equal to or better than the in place pavement. Restoration includes replacing and compacting excavated aggregate base with materials equal to those in the existing roadway and placing new bituminous surfacing equal to the existing, but not less than 0.25 feet (76 mm) in thickness. Place and compact the replacement bituminous surfacing to match the adjacent pavement providing a smooth riding surface, including the joints.

Maintain the restored pavement areas in good condition until the new pavement is placed.

603.04 METHOD OF MEASUREMENT.

603.04.1 Pipe. Pipe is measured by the linear foot (meter) in place from end-to-end of the installed structure along the bottom or pipe invert. Gasket material, specified coatings, coupling bands, bolts, bands, fittings, tees, risers, end sections, joint testing, restoring disturbed pavement, flared ends, beveled, skewed, and similar shapes or special designs, riser pipe lengths, and riser tee sections are not measured separately but are included in the pipe lengths measured.

Storm drain and sanitary sewer are measured by the linear foot (meter) from manhole center to manhole center.

Excess pipe installed and not ordered by the Project Manager is not measured for payment.

603.04.2 Excavation. Pipe excavation is measured by the cubic yard (cubic meter) under Subsection 207.04.

Foundation preparation and backfilling is included in the contract unit price for culvert excavation under Subsection 207.05.

When the imperfect trench backfill method is specified, the excavation of the fill and subsequent backfill in the prism above the pipe encasement is not measured separately.

603.04.3 Bedding and Foundation Material. Bedding and foundation material is measured by the cubic yard (cubic meter) in place.

603.05 BASIS OF PAYMENT.

603.05.1 Payment. Payment for the completed and accepted quantities is made under the following:

Pay Item	**Pay Unit**
Pipe (Type and Size)	Linear Foot (meter)
Excavation	Cubic Yard (cubic meter)
Bedding and Foundation	Cubic Yard (cubic meter)

Payment at the contract unit price is full compensation for all resources necessary to complete those items of work under the contract.

SECTION 604
MANHOLES, COMBINATION MANHOLES AND INLETS, AND INLETS

604.01 DESCRIPTION. This work is constructing manholes, combination manholes and inlets, and inlets.

604.02 MATERIALS.

604.02.1 General. Furnish materials and precast structures meeting the Contract requirements.

604.02.2 Concrete. Furnish Class "DD" concrete or equivalent meeting Section 551 requirements, except that precast concrete manhole riser sections must have a minimum 4000 psi (27.6 MPa) 28-day compressive strength.

604.02.3 Reinforcing Steel. Furnish reinforcing steel meeting Subsection 711.01 requirements.

604.03 CONSTRUCTION REQUIREMENTS.

604.03.1 General. Construct and install the structures as specified in the Contract.

604.03.2 Excavation. The Project Manager will establish the lines and grades for structure excavation.

Compact foundations meeting Subsection 203.03.3 to provide full bearing for the structures.

604.03.3 Backfill. Uniformly place backfill around structures in maximum 6-inch (155 mm) deep loose layers, and compact meeting Subsection 203.03.3.

Maintain the established structure lines and grades while backfilling.

604.04 METHOD OF MEASUREMENT. Manholes, combination manholes and inlets, and inlets are measured by the unit for each specified type, complete in place.

Excavation and backfill is incidental to and included in payment for the structures.

604.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Manhole, Manhole and inlet, and inlets	Each

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 606
GUARDRAIL AND MEDIAN BARRIER RAIL

606.01 DESCRIPTION. This work is furnishing, installing, removing, resetting, and revising metal beam guardrail, cable guardrail, and concrete median barrier rail and posts.

606.02 MATERIALS. Furnish metal beam guardrail, cable guardrail, and concrete median barrier rail meeting the following :

Steel Beam Guardrail and Fittings	Subsection 705.01.1
Guardrail Posts and Blocks	Subsection 705.01.2
Wire Rope and Connecting Hardware	Subsection 705.02
Concrete Median Barrier Rail	Section 554

606.03 CONSTRUCTION REQUIREMENTS.

606.03.1 General. Install guardrail and median barrier rail as shown in the Detailed Drawings and meeting the Contract requirements.

The Project Manager will establish the line and grade for terminal end sections. Establish line and grade between the terminal end sections.

Correct any vertical or horizontal mis-alignment to the specified line and grade at Contractor expense.

Individual guardrail runs shall normally be completed in one working day, including post placement and metal beam and the terminal section. Complete installation within 48 hours of starting work, on guardrail installations with difficult post placement conditions, which could not be completed in one working day without additional resources. Place hazard panels at maximum 50 foot (15.2 m) spacing to delineate partial installation areas (e.g. areas to receive guardrail but no work has begun) when work on those installations is not active.

Stop work when the excavation or post driving methods and equipment damages adjacent pavement.

Stop post driving that heaves the adjacent pavement more than ½-inch (13 mm) in 10 feet (3 m), measured with a 10 foot (3 m) straightedge parallel to the pavement.

Level and repair all damaged surfaces around installed posts as directed.

Use only one type of post, wood or concrete, for metal beam guardrail in each run, except where wood posts are specified.

When wood posts and blocks are damaged, cut or bored after treatment, treat the injuries, cuts, and holes with three applications of a copper naphthenate solution containing a minimum two percent copper metal or with chromated copper arsenate (CCA) complying with AWPA M4.

606.03.2 Placing Post By Excavation and Backfill. Dig post holes a minimum 18-inches (460 mm) in diameter.

Compact the post hole bottom, insert the post, backfill and compact around the post in 6-inch (155 mm) loose depth layers with the material at optimum moisture

before placing the next layer. Use power equipment to compact backfill. Maintain line and grade.

606.03.3 Driving Posts. Always drive steel posts. Wood and concrete posts may be placed by excavating and backfilling or by driving.

Use caps that protect the post top when driving posts.

Maintain the post alignment while driving the posts.

Fill voids between the soil and the post by backfilling and tamping. Re-compact loose material around the post and level the area as directed.

Remove, replace or re-install misaligned, loose or damaged posts at Contractor expense.

Pilot holes approximately 6-inches (155 mm) in diameter may be used when necessary.

606.03.4 Metal Beam Guardrail Erection. Install metal beam guardrail, including breakaway cable terminal assemblies (BCT), parabolic flares, end anchorages, and bridge approach sections installations as shown in the Detailed Drawings and meeting the Contract requirements.

Splice the metal rail units with the lap in the direction of traffic. Locate all splices at a post. Construct splices, laps, and terminal connectors as shown in the Detailed Drawings and meeting the Contract requirements. Splice the terminal connectors for attaching rail units to bridge ends to the rail units by lapping as shown in the Detailed Drawings.

Tighten the bolts through the splices and mounting bolts to a "snug tight" condition as defined in Subsection 556.03.9(E)(3)(a).

Assure bolts extend at least 1/4-inch (6 mm) beyond the nut. Place bolt heads on the traffic side of the guardrail.

Paint Contractor made holes, slots, or cut ends in new or salvaged metal guardrail with an approved galvanizing paint. Spot paint all bruised, broken, scaled, or damaged spelter coating on metal parts following the paint manufacturer's recommendations after erection.

606.03.5 Cable Guardrail. Install cable guardrail, including end anchorages meeting the Contract requirements and as shown in the Detailed Drawings.

606.03.6 Concrete Median Barrier Rail. Install concrete median barrier rail meeting the Contract requirements and as shown in the Detailed Drawings.

606.03.7 Remove and Remove and Reset Guardrail. Remove the existing guardrail from the specified locations meeting the applicable requirements of Section 202. Replace guardrail damaged during removal and re-setting at Contractor expense. Dispose of removed materials not to be reset or salvaged.

Provide all additional materials required to reset the guardrail to the Contract requirements at Contractor expense. Be responsible for the condition and care of the guardrail material during removal until final disposition.

All salvaged materials not damaged or defective and that meet the Contract requirements are available to the Contractor at no cost for use in the work. Stockpile

salvaged materials not designated for use in new installations as specified. These materials are the Department's property.

Backfill open post holes with clean, compactable material or crushed base or top surfacing, to the bottom elevation of the adjacent bituminous surfacing. Lightly spray the remaining portion of the hole with asphalt on the bottom and sides and backfill with plant mix bituminous surfacing. Compact the backfill and plant mix surfacing as specified.

Cutting off of existing posts is prohibited.

Use new materials meeting Subsection 606.02 to reset guardrail except as permitted above.

606.03.8 Raise Guardrail. Raise the existing guardrail to the specified height.

Raise guardrail by removing the rail elements or cable, and completely removing the post. Backfill and compact the post holes to the required depth, and re-install the posts and rail elements or cable to the specified height.

Replace all guardrail materials damaged during the work at Contractor expense.

Provide a smooth and uniform appearance at the specified height. Correct all horizontal and vertical alignment in the guardrail to the specified line and grade.

606.03.9 Revise Guardrail Elements. Reconstruct items designated to be revised as specified. The items include but are not limited to bridge approach sections, terminal sections, and end anchors.

606.03.10 Stiffened Guardrail Sections. Construct stiffened guardrail sections as shown in the Detailed Drawings.

606.04 METHOD OF MEASUREMENT.

606.04.1 Metal Guardrail. Metal guardrail, including terminal sections, is measured by the linear foot (meter) to the nearest 0.1 foot (0.1 m) from center-to-center of the end posts of each section.

606.04.2 Metal Guardrail End Anchors. BCT end anchors, 5 foot (1.5 m) radius end anchors, and buried end anchors are measured by the unit for each type specified.

606.04.3 Bridge Approach Sections. Bridge approach sections, including tapered curbs, are measured by the unit for each type specified.

606.04.4 Concrete Median Barrier Rail. Concrete median barrier rail, including the tapered ends, transition sections, and connections to existing median barriers, are measured by the linear foot (meter) to the nearest 0.1 foot (0.1 m) from end-to-end of each section. Measurement does not include those portions of median barrier constructed as an integral part of sign foundations.

606.04.5 Remove Guardrail and Reset Guardrail. Remove guardrail is measured by the linear foot (meter) from center-to-center of end posts of each section removed.

Reset guardrail is measured by the linear foot (meter) from center-to-center of the end posts of each section reset.

606.04.6 Raise Guardrail. Raise guardrail, including terminal sections, is measured by the linear foot (meter) from center-to-center of the end posts of each section.

606.04.7 Cable Guardrail. Cable guardrail is measured by the linear foot (meter) to the nearest 0.1 foot (0.1 m) from center-to-center of the end posts of each section.

606.04.8 Cable Guardrail Anchor Sections. Cable guardrail end anchor sections and road approach anchor sections are measured by the unit for each type specified.

606.04.9 Revise Guardrail Elements. Revise guardrail elements is measured by the unit for each element revised, as specified in the Contract.

606.04.10 Stiffened Guardrail Sections. Stiffened guardrail sections are measured by the linear foot (meter) to the nearest 0.1 foot (0.1 m) from center-to-center of the end posts of each stiffened section.

606.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following.

Pay Item	Pay Unit
Metal Guardrail	Linear Foot (meter)
Metal Guardrail End Anchor	Each
Bridge Approach Sections	Each
Concrete Median Barrier Rail	Linear Foot (meter)
Remove Guardrail and Reset Guardrail	Linear Foot (meter)
Raise Guardrail	Linear Foot (meter)
Cable Guardrail	Linear Foot (meter)
Cable Guardrail Anchor Sections	Each
Revise Guardrail Elements	Each
Stiffened Guardrail Sections	Linear Foot (meter)

Revise guardrail elements is paid for under "Revise Bridge Approach Section"-each, or "Revise Guardrail Terminal Section"-each.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 607
FENCES

607.01 DESCRIPTION. This work is constructing, removing and resetting barbed wire, combination barbed and woven wire, chain link fences and gates.

607.02 MATERIALS. Furnish materials meeting the following requirements:

Chain Link Fence	Subsection 712.01
Interstate and Farm Fence	Subsection 712.02
Class "F" Portland Cement Concrete	Section 551

Fence material acceptance test samples will be taken from the materials delivered to the project.

607.03 CONSTRUCTION REQUIREMENTS.

607.03.1 General Requirements. Construct fencing before any other work is performed on all parcels of land. This requirement may be waived where the Contractor has obtained a landowner written waiver. The waiver must state a completion date agreed to by the Landowner and Contractor for completing the fence work.

Maintain all existing fence enclosures. Close Contractor fence openings using new permanent fence, or use temporary fence, cattleguards, or watchman where new permanent fence cannot be constructed the same day.

Temporary fence may be used in place of new permanent fence if approved.

607.03.2 Clearing and Leveling Fence Lines. Keep clearing and leveling outside the fence line to a minimum.

Remove and dispose of trees, shrubs, brush, rocks, and other obstacles that interfere with the fence construction under Section 201. Contour the ground at the fence line to permit fence construction.

607.03.3 Constructing Chain Link Fence. Construct chain link fence as specified in the Contract and meeting the following requirements:

A. Posts. Set posts vertically, spaced at maximum 10 foot (3 m) centers, measured parallel to the ground surface.

Set posts for 5 and 6 foot (1.5 m and 1.8 m) fence in concrete. Set end, corner, and pull posts for 3 and 4 foot (0.9 m and 1.2 m) fence and line posts connected by bracing to end, corner, or pull posts in concrete. Drive or set in concrete, line posts on 3 and 4 foot (0.9 m and 1.2 m) fence as specified.

Use the footing dimensions and post embedment depths shown in the Detailed Drawings. Crown concrete footings to shed water.

Do not damage posts while driving them. Backfill and compact the voids around posts.

Set line posts placed in solid rock without soil overburden, at least 14-inches (360 mm) deep. When in solid rock, set end, corner, gate, and pull

posts at least 20-inches (510 mm) deep. Excavate or drill holes to a minimum width or diameter 1-inch (25 mm) greater than the largest dimension of the post being set.

Cut posts to the required length before installing. The Contractor may use an even post length set deeper into the solid rock at Contractor expense.

For metal posts placed in bored rock holes or consolidated soils, set the post plumb and fill the holes with grout that is one part portland cement and three parts clean, uniformly graded sand. Work the grout into the holes to eliminate voids. Concrete footings are not required where posts are set in bored holes.

Place posts, set in solid rock covered by soil or loose rock, to the specified depths or to the minimum solid rock depths specified above, whichever is less. When solid rock is encountered before reaching the specified depth, construct concrete footings from the solid rock to the top of the ground on 5 and 6 foot (1.5 and 1.8 m) fence and on end, corner, and pull posts for 3 and 4 foot (0.9 and 1.2 m) fence. Grout around that part of the post that is in solid rock.

Assure all posts are solid once they are driven, backfilled or concrete is placed.

B. Top Rail or Cable. Pass the top rails through the line post tops, providing a continuous brace from end-to-end of each fence section. Join top rail sections using sleeve-type couplings. Fasten the top rails to the terminal posts using pressed steel fittings.

Replace the top rails with a 3/8-inch (9.5 mm) diameter galvanized steel cable when fences are placed within 50 feet (15.2 m) from the edge of the nearest driving lane.

C. Fence Fabric. Place chain link fabric for 6 foot (1.8 m) fence on tangents, on the post face away from the highway. On 3 , 4 , and 5 foot (0.9, 1.2, and 1.5 m) fence, place the fabric as directed. On curves, place the fabric for all fence heights on the outside face of the posts on curves.

Place the chain link fabric on a straight grade between posts, leveling high points on the ground. Obtain the Project Manager's approval to fill in depressions along the fence line.

Stretch taut and securely fasten the fabric to the posts. Stretching by motor vehicle is prohibited. Use stretcher bars and fabric bands spaced at 1 foot intervals (305 mm) to fasten to end, gate, corner, and pull posts. Cut the fabric and attach each span independently at all pull and corner posts. Fasten fabric to line posts at 14-inch (360 mm) intervals with tie wire, metal bands, or other approved fasteners. Fasten the top edge of the fabric to the top rail or cable with tie wires spaced at 18-inch (460 mm) intervals.

Join rolls of wire fabric by weaving a single strand into the ends of the rolls forming a continuous mesh.

When a winged cattle guard is located in a chain link fence, extend the wire fabric beyond the post supporting the wing and securely fasten it to the wing.

D. **Tension Wire.** Attach a tension wire to the bottom of the chain link fabric using ring fasteners at 24-inch (610 mm) maximum intervals and secure at the terminal posts or pull posts using brace bands.

E. **Gates.** Fasten chain link fabric to the gate frame end bars using stretcher bars and fabric bands, and to the top and bottom of gate frame bars using tie wires for the chain link fence, or by other approved standard methods.

Clean welded connections on steel gate frames with burned spelter coating by wire brushing, to remove all traces of the welding flux and loose or cracked spelter. Paint the cleaned areas with two coats of zinc oxide-zinc dust paint mixed in a weight ratio of one part zinc oxide to four parts zinc dust.

Provide the drop-bar locking device for double metal gates with a 12-inch (305 mm) square by 15-inch (380 mm) deep Class "F" concrete footing crowned at the top. Provide a minimum 6-inch (155 mm) hole in the footing to receive the locking bar.

F. **Panels.** Install panels as shown in the Detailed Drawings.

Double panels at fence corners and angle points consist of one corner post, two line posts, two braces, two truss rods, two top rails, concrete, and other fixtures. Single panels at gates and fence ends consist of one gate or end post, one line post, one brace, one truss rod, one top rail, concrete, and associated fixtures.

607.03.4 Constructing Barbed and Woven Wire Fences. Construct barbed and woven wire farm and interstate fences meeting the Contract requirements and the following.

A. **Posts and Braces.** Excavate post holes, footing excavations, and anchors as shown in the Detailed Drawings.

Wood posts may be driven. Repair or replace all damaged posts at Contractor expense.

Treat cut or trimmed areas on posts and braces with three applications of a copper naphthenate solution containing a minimum of 2 percent copper metal or with chromated copper arsenate (CCA) meeting AWPA M4 requirements.

Securely nail braces to terminal and brace posts.

Metal posts not specified to be set in concrete may be driven. Place and grout metal posts placed in rock as specified.

Backfill and compact post hole material in 6-inch (155 mm) loose lifts.

Dampen holes before placing concrete. Assure the concrete has set before placing and stretching the fence wire or attaching gates to the posts and braces.

B. **Placing Wire.** After the posts, braces, and footings are set, place the woven wire and/or barbed wire, stretch it tightly, and fasten to the posts.

Apply tension following the wire manufacturer's recommendations with a mechanical or other approved wire stretcher. Do not use motor vehicles to stretch fence.

Diagonally drive U-shaped staples across the wood grain so both points enter different grains. Where wire uplift occurs, drive staples with the points slightly upward. On level ground and over knolls, drive staples slightly

downward. Staple the wire tightly at corner, end, and pull posts. The staples on line posts must allow wire movement without damaging the wire.

Place "Deadman" as shown in the Detailed Drawings at grade depressions, alignment angles, and other places where stresses might pull posts from the ground or out of alignment.

Install one metal line post in each 500 foot (152.5 m) wood post fence run and in smaller runs between gate post ends for lightening protection.

Construct gates as shown in the Detailed Drawings meeting Subsection 712.02 requirements.

607.03.5 Temporary Fence. Erect temporary fence to keep livestock and traffic out of the work area. Temporary fence may remain in place only during the work or until the fence is directed to be removed.

Use Type F3M as temporary fence for livestock enclosures. Construct all temporary fence from metal posts and materials meeting Section 712. Use the minimum number of braces, panels, deadman, and other accessories for constructing temporary fence.

Undamaged material used in the temporary fence that meets specifications may be used in the permanent fence. Material not used in permanent fencing remains the Contractor's property.

Remove temporary fence at Contractor expense.

607.03.6 Remove and Reset Fence. When removing and resetting a fence, furnish all required materials over and above the usable salvaged fence that are new materials meeting Section 712 requirements. Required new materials are listed in the Contract. Use, to the extent practical, materials of the same type and quality as those of the old fence that meet of Section 712 requirements.

Replace rotten, damaged, or broken posts and rusty, unusable wire with new material. Do not use any galvanized materials with abraded or broken coating.

Furnish all additional fence wire required for depressions.

Carefully handle and stockpile, at designated locations, all removed fence determined to be salvageable.

607.04 METHOD OF MEASUREMENT.

607.04.1 New Fence. Chain link fence is measured by the linear foot (meter) to the nearest foot (0.1 m). Interstate, farm, and temporary fence is measured by the linear foot (meter) and converted to rods (meter) to the nearest 0.1 rod (0.1 m). The measurements are made on the fence line along the top wire or rail or along a line parallel thereto, from end post to end post including wing fences to structures. Gates, cattle guards, or other openings are measured separately. Double sections of fence erected across depressions are measured for payment. All other temporary closures are included in the measurement of temporary fence. Temporary fence materials ordered by the Contractor but not used in the work will not be measured or paid for. Temporary fence removal is not measured separately.

607.04.2 Remove and Reset Fence. Remove and reset chain link fence is measured by the linear foot (meter). Remove and reset fence (interstate and farm)

is measured by the linear foot (meter) and converted to rods (meter) to the nearest 0.1 rod (0.1 m). Measurement of re-set fence in place is made under Subsection 607.04.1.

New posts and wire required to reset the removed fence is measured as follows:

1. Wood and metal posts are measured by the unit.
2. Barbed wire is measured by the spool. A spool contains 80 rods (402.6 m) of wire.
3. Woven wire is measured by the roll. A roll contains 20 rods (100.6 m) of woven wire.

The post and wire quantity specified in the contract is an estimate only. The actual quantity required to complete the work will be paid for at the contract unit price bid.

Panels required for remove and reset fence are not measured for payment.

607.04.3 Gates. Gates are measured by the linear foot (meter) between gate posts.

607.04.4 Fence Panels. Single and double fence panels are measured by the unit.

607.04.5 Deadman. Deadman are measured by the unit. Anchors are not measured for payment.

607.04.6 Dozer Operation. Dozer operation is measured by the hour under Subsection 210.04.1. When dozer operation is not a bid item, it is incidental to and included in other fencing items.

607.04.7 Remove Fence. Remove chain link fence is measured by the linear foot (meter). Remove fence (interstate and farm) is measured by the linear foot (meter) in place before removal along the top wire, or on a line parallel thereto, exclusive of gates, cattle guards, and other openings, and converted to rods (meter) to the nearest 0.1 rod (0.1 m).

607.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
New Fence Chain Link	Linear Foot (meter)
Interstate, Farm & Temp.	Linear Rod (meter)
Remove and Reset Fence Chain Link	Linear Foot (meter)
Interstate and Farm	Linear Rod (meter)
New wood or metal posts	Each
Barb Wire	Spool
Woven Wire	Roll
Gates	Linear Foot (meter)
Fence Panels	Each
Deadman	Each
Dozer Operation	Hour (see subsection 210.05)
Remove Fence	Linear Foot (meter)

The cost of removing existing fence is included in the cost of the new fence.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 608
CONCRETE SIDEWALKS

608.01 DESCRIPTION. This work is the construction of concrete sidewalks.

608.02 MATERIALS. Furnish materials meeting the following requirements.

Classes "A" and "D" Portland Cement Concrete	Section 551
Reinforcing Steel	Subsection 711.01
Joint Materials	Subsection 707.01

608.03 CONSTRUCTION REQUIREMENTS. Construct concrete sidewalks as specified in the Contract and as follows.

608.03.1 Subgrade and Forms. Excavate, shape, and compact the foundation to the specified width and grade.

Place and compact aggregate base to the specified thickness.

Use forms and form meeting Section 552 and Subsection 609.03 requirements.

608.03.2 Concrete. Furnish and place concrete meeting Section 551 requirements.

Place reinforcing steel as specified.

Dampen the foundation and forms immediately before placing concrete.

Do not place concrete on a frozen foundation course or subgrade.

Construct sidewalks meeting Subsections 501.03.18 and .19 requirements.

608.04 METHOD OF MEASUREMENT. Concrete sidewalk is measured by the square yard (square meter), including wheelchair ramps.

Reinforcing steel, expansion joint material, excavation, backfill, and disposal of surplus material are not measured for payment.

608.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Sidewalk-Concrete	Square Yard (square meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract. Material specified or directed to be excavated and not related to the sidewalk construction but necessary to place the sidewalk is paid for under Section 203.

SECTION 609
CURBS AND GUTTERS

609.01 DESCRIPTION. This work is constructing curbs, integral curb and gutter, median curbs, and furnishing and installing precast concrete curbs.

609.02 MATERIALS. Furnish materials meeting the following requirements:

Air-entrained Class "D" Concrete	Section 551
Reinforcing Steel	Subsection 711.01
Joint Materials	Subsection 707.01
Yellow Traffic Line Paint	Subsection 714.04
Bituminous Mixtures	Section 401

609.03 CONSTRUCTION REQUIREMENTS.

609.03.1 General. Construct curbs and integral curb and gutter having uniform surfaces and true lines. Remove and replace curb sections that prevent drainage or proper joining of subsequent work at Contractor expense.

Construct curbs and integral curb and gutter meeting the Contract requirements and as follows.

609.03.2 Foundations and Forms. Excavate, prepare and compact cast-in-place curb and curb and gutter foundations meeting the moisture and density requirements of Subsection 203.03.3.

Use full depth metal or straight-grained finished lumber forms, free of warp or irregularities, and having the strength to resist springing or deviation from alignment and grade. Securely stake and brace forms with headers and clamps. Clean and oil form surfaces in contact with concrete before placing the concrete.

609.03.3 Cast-in-Place Curb and Gutter. Moisten the foundations and forms immediately before placing concrete.

Place and consolidate the concrete in uniform layers not exceeding 6-inches (155 mm) loose depth.

Do not place concrete on a frozen foundation course or subgrade.

Construct concrete curb meeting Subsection 501.03.18 and .19 requirements.

Once the concrete has its initial set, remove the forms and repair honeycombed and rough surfaces using 1:2 mortar. Use wooden floats to remove form marks or other irregularities. Apply a brush finish to the final surface using an approved brush before the concrete sets. Finish all concrete edges, including those at expansion joints, to the required radii.

Water cure concrete or use a curing compound meeting Section 551.03.6 requirements. Water cure keeping the concrete wet for 7 days after finishing.

609.03.4 Slip-Formed Concrete Curb and Gutter. Concrete curb and gutter may be constructed using a curb forming or slip-form machine.

609.03.5 Precast Concrete Curbs. Furnish precast curb meeting Section 554 requirements and install as specified.

609.03.6 Bituminous Curbs. Clean surfaces receiving bituminous curb and prime with SS-1 emulsified asphalt diluted 1:1 with water. Apply approximately 0.2 gallon per square yard (0.91 L per m^2).

Use the project surfacing bitumen mixed with water in a mixer of at least 3 cubic feet (0.08 m^3) capacity, that meets Section 401 requirements.

The asphalt quantity in the bituminous curb mixture will be established by the Project Manager and will be at least 1% more than that used in the surfacing mixture.

Feed the bituminous mixture to the extrusion or curb machine at a temperature that prevents sloughing or tearing of the material or surface. Pressurize the mixture through an orifice or plate. The machine must heat and compact the curb as it is produced.

Compact all material not placed and compacted by the curb machine using mechanical tampers.

If other than 60-70 penetration asphalt cement is used, apply a fog coat of SS-1 emulsified asphalt diluted 1:1 with water to the finished curb at approximately 0.2 gallon per square yard (0.91 L per m^2).

609.03.7 Painting Curbs. Paint curbs, island curbs, and median curbs meeting Subsection 620.03.3(C) requirements.

609.04 METHOD OF MEASUREMENT. Curb, integral curb and gutter, median concrete curb, are measured by the linear foot (meter) to the nearest 0.1 foot (0.1m) along the face of the curb at the flowline.

Reinforcing steel, joint materials, excavation and foundation preparation, and emulsified asphalt for prime coat are not measured separately.

Paint and painting is measured by the gallon (Liter) under Subsection 620.04.

609.05 BASIS OF PAYMENT. Payment for completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Curb	Linear Foot (Linear Meter)
Integral Curb and Gutter	Linear Foot (Linear Meter)
Median Concrete Curb	Linear Foot (Linear Meter)
Paint	Gallon (liter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 610
ROADSIDE RE-VEGETATION

610.01 DESCRIPTION. This work is re-establishing vegetative cover on specified areas by topsoiling, seeding, planting, fertilizing, mulching, soil retention blankets, and sodding.

610.02 MATERIALS. Furnish materials meeting the following requirements.

Water	Subsection 713.01
Topsoil	Subsection 713.05
Seed	Subsection 713.08
Fertilizer	Subsection 713.09
Mulch	Subsection 713.10
Sod	Subsection 713.11
Soil Retention Blankets	Subsection 713.12

610.03 CONSTRUCTION REQUIREMENTS.

610.03.1 Topsoiling. Furnish topsoil and pay all royalty, development, smoothing and leveling costs of topsoil removal.

Notify the Project Manager of the proposed topsoil source(s) as soon as possible after the Contract award. Topsoil from proposed sources may be used only after sample tests show the material is acceptable.

Complete topsoil areas to the lines, grades, and elevations specified. Do not place topsoil until the designated areas are prepared and all construction work in the area is completed.

Scarify or rip slopes to be topsoiled.

Break up ordinary sod and soil containing grass roots into maximum 2-inch (50 mm) clumps.

Remove and dispose of all large clods, rocks, large roots, litter, and other foreign material in spread topsoil at Contractor expense. Break up the topsoil to an average depth of 4-inches (105 mm).

610.03.2 Seeding, Fertilizing, and Mulching. These requirements apply to establishing vegetation on areas disturbed by the work. Landscaping interchange areas, rest areas, urban areas, and other areas are specified elsewhere in the Contract.

A. General. Work the areas to be seeded to the specified line and grade before seeding and fertilizing.

Seed all disturbed areas. Permanent seeding of the finished slopes may require multiple seeding. Fertilizing, mulching, permanent erosion control placement, and seeding are specified in the Contract.

B. Seeding Season. The seeding season is October 15 through May 1. Obtain the Department Agronomists approval to seed outside this period.

C. Conditioning Seedbed Surface. Condition the seedbed surface area by killing growing weeds, removing or mowing old weedy growth, tilling, discing, harrowing, or scarifying compacted areas, and compacting unstable areas.

Condition all seeding areas unless otherwise directed. The Project Manager may exclude wet, soft or rocky areas from conditioning.

Cultivating, tilling, harrowing, discing, and similar work may, if approved, be performed any time after the Contract is awarded.

Break up tight or compacted soils into 2-inch (50 mm) or smaller pieces. Remove or repair discs, harrows, cultipackers, and similar equipment not in good operating condition. Operate discing, harrowing, and soil tilling equipment at right angles to the natural slopes.

Prepare soil using equipment that produces a rough-textured surface ready for seeding and mulching. Operate equipment normal to the natural slopes. The final surface must be 1 to 1½-inches (25 to 40 mm) below the tops of curbs, catch basins, and other structures.

Rescarify areas to be broadcast seeded within 48 hours before seeding.

D. Seed Distribution.

1. **General.** Apply seed within 48 hours of the final seedbed conditioning.

   Do not broadcast seed or hydraulic seed when weather conditions prevent uniform seed distribution.

   Do not cover seed with more than 1/2-inch (13 mm) of soil.

   The seed application rate is specified in the Contract.

2. **Drill Seeding.** Drill seed slopes 3:1 and flatter using equipment that regulates the seed application rate and planting depth. Acceptable drills are custom seeders, furrow drills, disc drills, or other approved drills. If seed sowing equipment does not have press wheels, compact the seed using a cultipacker once the ground has been drilled.

   Maintain uniform seed distribution in the drill hopper during the work.

   Operate all seeding related equipment at right angles to the slope.

   Regulate planting depth with depth bands or coulters. Use a drill box partitioned by dividers a maximum 24-inches (610 mm) apart.

   Seed rows a maximum 8-inches (205 mm) apart and at right angles to the slope.

3. **Broadcast Seeding.** Hand seeding or mechanical seeding of slopes exceeding a 3:1 slope, narrow medians, or small areas is permissible.

4. **Hydraulic Seeding.** Hydraulic seeding is permissible for slopes steeper than 3:1 or when the seedbed surface is impractical to drill seed.

   Perform hydraulic seeding in two operations.

   a. Apply the seed with 1 pound (0.454 kg) of wood or recycled paper mulch per 3 gallons (11.3 L) of water.

   b. Apply the remaining mulch, along with fertilizer, if specified. See Subsection 610.03 (F)(5).

E. Application of Fertilizer. When broadcasting seed, apply the fertilizer separately.

When drill seeding do not apply seed and fertilizer in a single mixture. The fertilizer must be applied separately, either broadcast before seed application, or surface banded during seeding.

F. Mulching.

1. **General.** Use the mulch type specified in the Contract.

   Apply mulch to seeded areas within 24 hours after seeding without disturbing the seedbed surface.

   Do not apply mulch to ground having free surface water or if wind prevents uniform distribution.

2. **Application of Vegetative Mulch.** Uniformly apply vegetative mulch with a mulch spreader at the specified rate once seeding and fertilizing are completed.

   Secure all vegetative mulch to the slopes with a non-asphalt based tackifier containing either plant derived hydrocolloid or polymeric materials. Add the tackifier to the fertilizer/mulch slurry when wood cellulose or recycled paper fibers are used as an over-spray onto the straw/hay mulch.

   Tuck vegetative mulch on slopes 3:1 or flatter into the seedbed. Use a mulch tiller for tucking. Operate the equipment perpendicular to the slope.

   Use mulch tillers having round, notched blades approximately 1/4-inch (6 mm) thick by 18-inches (460 mm) in diameter spaced 8-inches (205 mm) apart that force the vegetative mulch at least 3-inches (75 mm) into the soil. Equip tillers with disc scrapers.

   If temporary erosion controls are needed, straw tucking followed by permanent seeding within the seeding season are acceptable measures.

3. **Applying Fabricated Mulch or Netting.** Place fabricated mulch or netting on the specified or directed areas, securing it to the ground using wire staples, wood pegs, or other approved devices. Apply the mulch or netting over the seeded areas.

4. **Applying Wood Cellulose Fiber or Recycled Paper Mulch.** Apply wood cellulose fiber or recycled paper mulch and fertilizer in one operation with a hydraulic distributor using water as the vehicle. Equip the distributor with a continuous agitator keeping the fertilizer and mulch uniformly suspended throughout the distribution cycle. Adjust the pump pressure to maintain a continuous slurry stream. Size the slurry distribution lines to prevent plugging. Equip the discharge line with hydraulic spray nozzles to uniformly distribute the slurry to the seedbed.

   Start mulching at the top of the slope and work downward. Use extension hoses to reach the slope extremities.

5. **Finishing.** Re-mulch areas where mulch is weather damaged.

   Repair seedbed and seeding damage caused by displaced mulch material and re-seed the areas before re-mulching. Seedbed repair, re-seeding, and re-mulching required due to the Contractor's negligence is at Contractor expense.

610.03.3 Sodding.

A. Season. Perform sodding during the normal seeding season or as specified.

B. Source of Materials. Notify the Project Manager of the sod source(s) at least three days before sod cutting begins. Cut and deliver only approved sod to the project.

C. Surface Preparation. Prepare the surfaces to be sodded to the required cross section, grade, and contour. Make the surface smooth and uniform, free of stones, roots, lumps, weeds, and other foreign material. Undercut the prepared surface below the adjacent areas so the top of the new sod is flush with adjacent seedbed or turfed areas and 1-inch (25 mm) below sidewalk and curb tops.

Break the surface up to a fine, granular texture at least 2-inches (50 mm) deep before placing sod.

Fertilize the surface to be sodded a maximum 48 hours before placing sod. Use inorganic fertilizer having minimum active ingredients of 15 pounds (7 kg) of Nitrogen and 40 pounds (18 kg) of P_2O_5 per acre (17 kg Nitrogen, 44 kg P_20_5 per hectare).

D. Cutting and Handling Sod. Machine-cut sod in uniform rectangular sections.

Cut sod to a depth that retains intact, the grasses live dense root system and prevents tearing or breaking of the sod.

Load, unload, and place sod to prevent tearing or breaking of the sod.

E. Placing Sod. Lay sod within 36 hours of cutting. Protect sod from dry or cold weather until placed.

Place and fit sod as close as possible staggering the joints between horizontal rows.

Lay the sod strips horizontally on slopes, starting at the slope bottom and work upwards. On slopes steeper than 3:1, anchor the sod with fasteners spaced a maximum 2 feet (610 mm) apart and driven flush with the sod surface.

In waterways, lay the strips parallel to the flow, staggered, and fitted snug and even with the strips already placed.

Fill gaps between sod strips with sod pieces cut to the gap size and shape.

At slope bottoms, extend the sod edges at least 2-inches (50 mm) into the ground or ditch bottom. Turn all other sod area edges into the ground and cover with topsoil, compact and smooth to blend with the adjacent finished grades.

Roller compact the sod with a roller immediately after placement. Provide a smooth, even surface, free from bumps and depressions.

Thoroughly water the sod and re-roll to insure good soil contact.

F. Sod Maintenance. Water new sodded areas until the sod is firmly rooted.

Maintain the new sod until it is well rooted and replace all dead, dying, and damaged sod as directed at Contractor expense.

610.03.4 Erosion Control Blanket. Prepare, fertilize, and seed the erosion control blanket areas before placing the blanket. Handle and place it following the manufacturer's recommendations. If recommendations are not provided, install as follows:

1. In ditches, unroll the blanket downstream and lap 4-inches (105 mm) over the adjoining blanket. Bury the ends and edges to prevent water and wind undercutting.
2. On slopes, the blanket may be unrolled horizontally or vertically to the slope, then lapped 4-inches (105 mm) over the adjoining blanket and stapled as above. Always lap the blanket in the direction of flow.

610.04 METHOD OF MEASUREMENT.

610.04.1 Topsoil. Topsoil is measured by the cubic yard (cubic meter) of loose material level with the haul vehicle box at the point of use on the project. Strike or level loads when directed.

610.04.2 Seeding. Seeding is measured by the acre (hectares), parallel to the ground surface, to the nearest 0.1 acre (0.1 ha).

610.04.3 Fertilizing. Fertilizing is measured by the acre (hectares), parallel to the ground surface, to the nearest 0.1 acre (0.1 ha).

610.04.4 Condition Seedbed Surface. Condition seedbed surface is measured by the acre (hectare), parallel to the ground surface, to the nearest 0.1 acre (0.1 ha).

610.04.5 Mulch.

A. **Vegetative Mulch and Wood Cellulose Fiber Mulch.** Vegetative mulch and wood cellulose fiber mulch is measured by the acre (hectare), parallel to the ground surface, to the nearest 0.1 acre (0.1 ha).
B. **Fabricated Mulch and Netting.** Fabricated mulch and netting is measured by the square yard (square meter) in place.
C. **Bituminous Mulch.** Bituminous mulch is measured by the gallon (Liter) for the gallons (liters) applied at the specified rate.

610.04.6 Sodding. Sodding is measured by the square yard (square meter) in place, parallel to the ground surface.

Re-sodded areas damaged from causes not the fault of the Contractor are measured for payment.

610.04.7 Soil Retention Blanket. Soil retention blanket is measured by the square yard (square meter) in place.

610.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Topsoil	Cubic Yard (Cubic Meter)
Seeding	Acre (Hectare)
Fertilizing	Acre (Hectare)
Condition Seedbed Surface	Acre (Hectare)
Mulch	Acre (Hectare)
Fabricated Mulch and Netting	Acre (Hectare)
Sodding	Square Yard (Square Meter)
Soil Retention Blanket	Square Yard (Square Meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of the work under the contract.

SECTION 611
CATTLE GUARDS

611.01 DESCRIPTION. This work is furnishing and installing cattle guards or removing and resetting cattle guards.

611.02 MATERIALS.

611.02.1 Concrete. Furnish air-entrained Class "A" portland cement concrete meeting Section 551 requirements for poured-in-place base concrete.

Furnish Class "D" portland cement concrete meeting Section 551 requirements for precast bases.

611.02.2 Steel. Furnish reinforcing steel meeting Subsection 711.01 requirements.

Furnish low-alloy weldable steel meeting ASTM A 572 (A 572M), Grade 45 (300 MPa) requirements for crossbars.

Furnish other steel meeting Section 711 requirements.

611.02.3 Paint. Furnish paint meeting the following requirements:

A. Shop (Prime Coat) . . . . . Subsection 710.02(B)7
B. Aluminum Paint (Finish Coat) . . . . . Subsection 710.02.(B)2

611.02.4 Prefabricated Cattle Guards. Furnish standard pre-fabricated cattle guards meeting Standard H-20 (M 518) loading that have cleanouts. Submit for approval all fabrication details before fabrication and footing elevations are set.

611.03 CONSTRUCTION REQUIREMENTS.

611.03.1 Excavation. Excavate cattle guard foundations to the specified depth allowing space for formwork.

Complete and compact earth fills meeting Section 203 requirements before excavating for the cattle guard foundation.

611.03.2 Placing Concrete Bases. Construct poured-in-place concrete bases meeting Section 552 and the Detailed Drawings.

Furnish precast concrete bases meeting Section 554 requirements and the Detailed Drawings.

Construct stringer bearing surfaces to provide full bearing under each stringer. Bushhammer uneven surfaces to provide even bearing.

611.03.3 Placing Cattle Guards. Fasten the metal structure to the base as specified.

Attach the metal wings to the cattle guard and to the fence as shown in the Detailed Drawings.

All welding must meet the requirements of Subsection 556.03.10.

Backfill and clean up around the completed structure.

611.03.4 Painting. Apply one shop coat of primer to all metal parts. Apply a prime coat and a finish coat in the shop or in the field.

Perform all painting meeting the applicable requirements of Section 612.

Re-paint damaged painted surfaces at Contractor expense.

611.03.5 Re-setting Cattle Guards. Dismantle and reset existing cattle guards at the locations specified in the Contract.

611.04 METHOD OF MEASUREMENT. New and re-set cattle guards are measured by the unit, including the concrete bases, excavation and backfill.

611.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
New Cattleguard	Each
Reset Cattleguard	Each

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 612
PAINTS AND PAINTING

612.01 DESCRIPTION. This work is the surface preparation, furnishing and applying the paint, and protecting the paint coatings, pedestrians, vehicular, or other traffic upon or under the surface being painted.

612.02 MATERIALS. Furnish materials meeting the applicable requirements of Section 710 and 612.02.1.

612.02.1 Coating System for Structural Steel. Furnish a complete coating system consisting of a self-curing zinc-rich primer, an intermediate coat of high-build epoxy paint and a protective top coat of urethane paint meeting Subsection 710.02.3 © requirements. The epoxy color must be white and the urethane color is specified in the Contract.

612.03 CONSTRUCTION REQUIREMENTS.

612.03.1 Coating Systems for Structural Steel. Submit a written description of the coating system to the Project Manager for approval at least 30 days before starting work.

Include in the written submittal the manufacturer's product information including but not limited to paint characteristics, surface preparation, film thickness recommendation, safety data, repair procedures and application recommendations.

Bring conflicts between the coating system submittal and the specifications to the Engineer's attention for resolution.

Furnish the services of a paint or painting technical representative from the paint manufacturer at the beginning of paint operations and as required during operations.

Shop apply the primer. Shop or field apply the intermediate and top coat. Protect all coats from damage during handling, transporting, and unloading. Repair all paint damage following the coating manufacturers recommendations at Contractor expense.

612.03.2 Protection of Structure, Persons, and Property. Protect pedestrian, vehicular, and other traffic upon or under the structure, the super-structure and substructure against damage or disfigurement by spatters, splashes, smirches, or over-spray of paint or paint material. Clean and remove all paint damage at Contractor expense.

A. Pollution Controls. Prevent environmental pollution including stream and air pollution caused by paint, paint spray, paint chips, dust, or other harmful materials meeting all Federal, State, and local regulations and requirements.

612.03.3 SURFACE PREPARATION. Prepare surfaces to be painted following the paint manufacturer's recommendations, or the following, whichever is most restrictive.

A. **Structural Steel for Bridges.** Clean oil and grease from surfaces to be coated before blast cleaning. Solvent clean oil or grease coated surfaces to meet SSPC-SP 1 requirements.

Surface clean by the centrifugal wheel or the air blast method. Blast clean meeting SSPC SP-6, Commercial Blast Cleaning requirements.

Hand-clean the steel bridge bearing components containing PTFE (polytetraflourethylene), stainless steel surfaces, and neoprene pads to prevent surface damage.

Remove fins, tears, slivers, and burred or sharp edges by grinding and re-clean the area as specified before coating.

Remove blast residue from steel surfaces with clean brushes, compressed air, or a commercial grade vacuum cleaner equipped with a brush-type cleaning tool, or by double blowing. Keep steel dry, dust free and prime steel within 24 hours after cleaning.

Clean structural steel that is not shop painted to meet SSPC SP-7 requirements after erection. Guard angles, pier nose angles, deck expansion joints, and other small structural steel elements may be prepared for painting using wire brushes, scrapers, chisels, or sand blasting as approved.

B. **Galvanized Metal Surfaces.** Treat galvanized metal surfaces to be painted using phosphoric acid solutions of the zinc phosphate and phosphate chromate types formulated for this use. Dry the treated surfaces 20 minutes, then rinse with water. Begin painting within 24 hours.

C. **Previously Painted surfaces.** Clean to meet SSPC SP-7 requirements.

D. **Steel not to be painted.** Steel may be cleaned before or after erection.

612.03.4 REMOVING LEAD BASED PAINT.

A. **Pre-qualification.** Submit a work plan, that meets OSHA and EPA regulations, as a pre-qualification for lead paint removal work at least 20 days before the bid letting date. Address the work plan to: Construction Engineer, Montana Department of Transportation, 2701 Prospect Ave., Helena, MT., 59620.

Work plans will be reviewed for acceptance within 5 working days of receipt. The Department will notify the Bidder in writing of the plans acceptance or rejection. Rejected plans may be re-submitted once only and must be received by the Department at least 5 working days before bid letting to be considered for acceptance. The approved work plan of the successful bidder becomes a part of the contract upon award.

B. **Work Plan.** Have the work plan prepared by an individual who has experience with, and worked under, OSHA and EPA regulations and will supervise the work covered by the plan. Include the individuals resume listing qualifications, experience, and references.

Work plans consisting only of copies of specifications and regulations will be rejected.

Address the following items in the written work plan:

1. **Worker Protection.** Meet the OSHA lead standards of Title 29, CFR 1926.62. Describe medical surveillance, exposure monitoring, respiratory protection, personal hygiene, employee training, employee

access to records, hazard communication and a compliance program to reduce lead exposure to within the Permissible Exposure Limits (PELs). Exposure monitoring must meet NIOSH Method 7082.

Provide the Engineer copies of pulmonary capacity tests, copies of employee training certificates, and the blood test results from all workers involved in the paint removal. Take one test before beginning work, then every 4 weeks thereafter until the work is complete. The Engineer may adjust the frequency based on the tests results. Take the final blood test within 2 weeks of completing the paint removal.

2. **Environmental Protection.** Design a containment system meeting SSPC 1,2 or 3 " Guide for Containing Debris Generated During Paint Removal" requirements except that permeable wall materials cannot be used. The containment system may be located on or off the project site. Submit shop drawings and design calculations for containment systems attached to the structure . Include design calculations that address all load conditions on the structure resulting from the containment system including debris. Specify ventilation and negative pressure equipment capacity, layout, and related calculations.

C. **Air Quality.** Test and monitor air quality for particulate and lead matter under Part 40 CFR 50. Sample air quality before construction for background particulate matter. Monitor air quality during construction until four consecutive samples show emissions not exceeding 400 $\mu g/m^3$ of PM_{10} over a 8-hour period. If emissions exceed 400$\mu g/m^3$, stop work until the containment system is corrected to meet the required air quality level. Use high volume monitors placed upwind for background levels and downwind of the work and near the right of way line for monitoring emissions.

Sample air quality for lead before and during construction. Test background levels before construction by placing the monitor upwind of the project.

Take 4 consecutive samples when construction starts from monitors placed downwind and near the right of way line to determine emission levels. The maximum allowable emission in an 8 hour period is calculated by the following formula:

AE = 90/PD X 1.5 $\mu g/m^3$ X 3

Where: AE = 8-hour allowable emission in $\mu g/m^3$
PD = Project duration in days

The Maximum and minimum value for PD is 90 and 30 respectively.

Stop work when samples exceed the allowable AE until the containment system is corrected and emissions fall within the acceptable limits.

D. **Soil Quality.** Do not contaminate the soil with lead. The Department will take soil samples before and after construction for contamination testing. The Contractor is responsible for all work and costs to restore the soil to the condition represented by the pre-construction sample.

E. **Water Quality.** Do not contaminate any water system with lead debris (spent abrasive, paint chips, etc). The Department will take sediment

samples below and downstream of the project before and after work begins for contamination testing. The Contractor is responsible for all work and cost to restore the water system to the condition represented by the pre-construction sample.

F. **Disposal.** Contain and store the material meeting the approved plan. The Department is responsible for disposal.

612.03.5 APPLICATION OF PAINT.

A. **General.** Do not paint when weather conditions would cause unsatisfactory work. Follow the paint manufacturer's recommendations for surface temperature and dewpoint/temperature requirements. The Project Manager may stop painting at any time if current or impending weather conditions could cause unsatisfactory coating performance.

Correct failures or damage to new painted surfaces at Contractor expense. Provide a minimum dry film thickness of 1.5 and 1.0 mils (35 μm and 25 μm) respectively for each primer and succeeding field coat of paint over metal unless the paint manufacturer recommends otherwise.

Provide the inspectors ready and safe access to the work at all times. The Project Manager will suspend work for unsafe or inadequate access facilities. Assure all fabrication inspections are complete before beginning painting.

B. **Painting Structural Steel.**

1. **Application.** Apply 3 coats of paint to all new structural steel. This includes but is not limited to steel and metal structures such as bridge rail, sign posts, and sign structures exposed to the weather. Paint in a neat and workmanlike manner.

Follow the paint manufacture's recommendation when brush or spray painting to produce a uniform, even coat to the metal or previous paint coat. Brush paint thoroughly coating the surface irregularities and brush out and smooth to produce an even paint film thickness. Equip spray pressure tanks with an agitator that thoroughly stirs the paint.

Stir the paint as recommended by the manufacturer before removing it from the containers and during application. The Project Manager may approve hand mixing when each coat of paint is 5 gallons (20 L) or less.

Follow the manufacturer's recommendations for paint thinning.

Paint surfaces inaccessible to paint brushes with sprayers or daubers made for that use.

Protect painted surfaces from adverse weather until the paint has dried or weather permits removing the cover.

Remove and replace unsatisfactory paint work at Contractor expense.

2. **Shop Paint.** Apply one coat of zinc rich primer to all metal surfaces, except surfaces in contact after erection. Apply the shop coat immediately after the fabrication, shop inspection, and shop cleaning are complete and the work has been accepted.

Do not paint metal surfaces that are in contact with other items after erection except as specified in Subsection 612.03.5(C)(1). Do not pack

or ship materials until the paint is dry. Field coats may be applied in the fabrication shop only if approved in writing by the Engineer.

Make erection marks for the field identification of members on painted surfaces. Assure erection marks, fabricator's name, or other identification does not show through the final coat of paint. Use marking paint that is compatible with the shop coat and first field coat.

Shop coat machined-finished surfaces, excluding abutting chord splices, column splices, and column and truss shoe bases as soon as practical after acceptance with a zinc-rich primer coat. Machine finished iron and steel casting surfaces to remove scales, scabs, fins, blisters, and other surface deformations must be painted with a zinc-rich primer.

3. **Field Cleaning.** Remove all rust, scale, dirt, grease, unacceptable shop paint and other foreign material following the paint manufacturers recommendations when erection work is complete.
4. **Field Painting.**
   a. **Application Conditions**. Apply paint following the manufacturers recommendations for temperature (air, surface, material), relative humidity and substrate temperature or as follows, whichever is more restrictive.

      Do not apply paint when the ambient temperature is 40 °F (5 °C) or is expected to drop below 40 °F (5 °C) within 2 hours of application.

      Do not apply paint when rain, snow, or condensation is expected within two hours after application at the painting location. The Project Manager may stop paint operations when impending weather could harm freshly applied paint. Do not apply paint when the relative humidity is greater then 85% or when temperature and humidity cause condensation on the surface to be painted.

      Do not apply paint to metal with surface temperatures that exceed 110 °F (40 °C) or when the surface temperature causes the paint to blister or produce a porous paint film.

   b. **Accessory Preparations and Spot Painting.** Thoroughly clean masonry and sole plates, the outside faces of end floor beams, the bottom of expansion devices, and all parts of steel work inaccessible for painting after erection of all foreign material. Spot coat and apply two field coats. Perform the painting on site and allow it to thoroughly dry before assembling. Handle painted material to prevent paint damage. Repair and repaint damaged surfaces at Contractor expense.

      Apply the primer shop coat only to the exposed surfaces of bridge deck guard angles, approach slabs, expansion devices, and armored joints embedded in the roadway surface. Apply two coats of field paint to the entire curb or sidewalk portion of these members as specified elsewhere in this Section.

      After erection and field cleaning is approved, apply the spot coat to the edges of the plates, rolled shapes and angles, to the heads of all field rivets, pins, nuts and areas where the shop coat has been damaged. The Project Manager may require a complete

shop coat reconditioning or replacement on damaged surfaces at Contractor expense.

Re-seal small cracks and cavities left by the first coat with a zinc paste before applying the second field coat.

c. Field Coating. Once the field cleaning is complete and the spot coat is thoroughly dried, apply one field coat of epoxy paint to all metal and the finish coat of urethane paint. Do not apply the urethane until the epoxy has dried as recommended by the paint manufacturer.

d. Painting Season. Field painting season for structural steel, metal posts or poles, and bridge rail is from May 1 to October 31, unless otherwise approved in writing by the Project Manager.

C. Painting Bridge Rail.

1. Metal Bridge Rail. Prepare metal bridge rail to be painted meeting the applicable requirements of Subsection 612.03.3.

Apply the spot coat and the first and second field coats before erection and fit-up to the following contact surfaces:

a. Rail to post contact surfaces;
b. Bridge rail expansion sleeves;
c. Bridge rail post base plates.

Apply the first and second coat to the rest of the rail after erection, fit-up, and final adjustment of the rail to line and grade.

Repair coating damage to galvanized members with an approved zinc-rich paint.

2. Wood Rail and Posts. Primer and paint for wood rail and posts are specified in the Contract. Apply paint meeting the applicable requirements of Subsection 612.03.05.

612.04 METHOD OF MEASUREMENT. Paints and painting is not measured separately but is incidental to the items being painted.

612.05 BASIS OF PAYMENT. Paints and painting is not paid for separately but is included in the cost of the item painted and includes all materials and resources necessary to complete the work.

SECTION 613
RIPRAP AND
SLOPE AND BANK PROTECTION

613.01 DESCRIPTION. This work is the construction of protective rock, stones, gravel, or concrete coverings as specified.

Riprap is a cover of stone or fragmented rock, with or without grout, placed along embankment slopes, stream banks, culvert inlets and outlets, foundations, bridge berms, dikes, and other specified locations.

Bank protection is a cover of rock or coarse gravel placed on the side slopes of structure channels and other specified locations.

Concrete slope protection is a cover of portland cement concrete placed on slopes at structure ends.

613.02 MATERIALS. Furnish materials meeting the following requirements:

Handlaid, Random, and Grouted Riprap	Subsection 701.06
Cement Grout	Subsection 713.04
Bedding Material	Subsection 701.04.1
Bank Protection	Subsection 701.07
Class "D" Portland Cement Concrete	Section 551
Sand-Gravel Cushion	Subsection 701.08

613.03 CONSTRUCTION REQUIREMENTS.

613.03.1 Riprap.

A. General. Place the riprap at the locations specified in the Contract.

Key the riprap ends into the embankment slopes at least 2 feet (610 mm) from the outer face of the riprap for the full height of the riprap.

B. Handlaid Riprap. Bed the stones at right angles to the slope with the larger stones used in the lower courses. Lay the stones in close contact with staggered vertical joints and placed so each stone rests on the embankment slope instead of the underlying stones. Fill the spaces between the stones with smaller stones or rock, securely placed.

Finish the work to present an even, tight plane varying no more than 3-inches (75 mm) from the general contour of the revetment.

Provide a minimum riprap thickness of 12-inches (305 mm), measured perpendicular to the slope, or as specified.

C. Random Riprap. Place the stones on the slopes to form the specified cross section. Uniformly distribute the smaller stones throughout the work. Manipulate the stones by hand or machine to provide a uniform surface and stable mass.

Provide the riprap thickness specified on the plans.

Place the riprap around pipe openings without damaging the pipe. Repair damaged pipe at Contractor expense.

D. Grouted Riprap. Provide a minimum riprap thickness of 9-inches (230 mm) measured perpendicular to the slope, or as specified.

Place one or more layers of bedding material before placing the riprap as specified. Place each bedding layer on the prepared surface to the specified thickness in one operation without segregating the layer. Finish the top layer to produce an even surface free from mounds or ridges. Do not inter-mix the materials of each layer.

Fill the voids between stones with spalls or small stones so all stones are wedged or keyed. Prevent earth and sand from filling the spaces between the stones.

Finish the final surface to provide an even, tight surface with the plane not varying more than 3-inches (75 mm) from the general contour.

Wet the riprap surface and fill the crevices and openings with at least 3-inches (75 mm) of mortar. Immediately sweep the surface with a stiff broom.

Grouting may begin when the ambient temperature is at least 35 °F (2 °C) and rising and must stop when the ambient temperature is 30 °F (-1 °C) and falling.

Keep finished grout work moist for three days.

613.03.2 Bank Protection. Bank protection may be hand-placed or machine placed and leveled. Construct the finished bank protection to be stable with no voids larger than the smallest stone used in the work.

Use rock spalls or gravel to fill the voids. Not more than 5% of the total bank protection volume may be earth, sand, or rock material smaller than 3/16-inch (5 mm) for filling voids.

Bed the bank protection as shown in the Contract.

613.03.3 Concrete Slope Protection. Trench, shape, compact, and trim the slopes as specified before starting concrete work. Excess excavated material may be used elsewhere in the work or disposed of by the Contractor.

Construct the concrete slope protection as specified or directed.

613.04 METHOD OF MEASUREMENT.

613.04.1 Riprap.

A. Handlaid and Random Riprap. Handlaid and random riprap is measured by the cubic yard (cubic meter) to the nearest 0.1 cubic yard (0.1 m^3) complete in place. The volume measured for payment is that bounded by the staked length and height and the plan thickness.

Excavation is incidental to and not measured for payment.

B. Grouted Riprap. Grouted riprap is measured by the square yard (square meter) to the nearest 0.1 square yard (0.1 m^2) on the face of the revetment.

Excavation is incidental to and not measured for payment.

Bedding material is measured by the cubic yard (cubic meter) to the nearest 0.1 cubic yard (0.1 m^3).

613.04.2 Bank Protection. Bank protection is measured by the cubic yard (cubic meter) to the nearest 0.1 cubic yard (0.1 m^3) complete in place. The volume

measured for payment is that bounded by the staked length and height and the plan thickness.

Excavation and bedding material is not measured for payment.

613.04.3 Concrete Slope Protection. Concrete slope protection is measured by the square yard (square meter) to the nearest 0.1 square yard (0.1 m^2). Measurement is made parallel to the surface of the exposed surface area including the surfaces of curbs and head walls. Excavation is incidental to the item and not measured for payment.

Sand-gravel cushion is measured by the cubic yard (cubic meter) compacted in place.

613.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	**Pay Unit**
Handlaid and Random Riprap	Cubic Yard (cubic meter)
Grouted Riprap	Square Yard (square meter)
Bank Protection	Cubic Yard (cubic meter)
Concrete Slope Protection	Square Yard (square meter)
Bedding Material	Cubic Yard (cubic meter)
Sand-Gravel Cushion	Cubic Yard (cubic meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 614
RETAINING WALLS

614.01 DESCRIPTION. This work is constructing concrete and metal bin-type retaining walls.

614.02 MATERIALS. Furnish materials meeting the following requirements:

Concrete	Section 551
Reinforcing Steel	Subsection 711.01
Metal Bin-Type Retaining Walls	Subsection 711.21
Backfill For Metal Bin-Type Retaining Walls	Subsection 701.09

614.03 CONSTRUCTION REQUIREMENTS.

614.03.1 Foundations. Excavate and prepare foundations for concrete retaining walls meeting the applicable requirements of Subsection 209.03.

Construct metal bin-type retaining wall foundations to the established lines and grades and compact meeting Subsection 203.03.3 requirements.

The Project Manager will inspect and approve all foundations before subsequent work.

614.03.2 Concrete Retaining Walls. Construct concrete retaining walls as specified in the Contract. Perform concrete work meeting the applicable requirements of Section 552.

Remove all deleterious material from the footings before placing concrete. Prepare the footing surface meeting the requirements for bonding construction joints in Subsection 552.03.7. Make vertical construction joints as specified in Subsection 552.03.7.

614.03.3 Bin-Type Retaining Walls. Assemble the wall parts following the wall manufacturer's recommendations.

If approved, the wall height and depth may be varied but can not exceed the maximum dimension shown.

Two or more retaining wall designs may be used in the same wall using standard split columns to make the stepback connection.

614.03.4 Backfill.

A. **Concrete Structures**. Furnish the backfill material specified in the Contract. Place backfill as specified in Subsection 203.03.2(B).

B. **Metal Bin-Type Retaining Walls.** Follow the manufacturer's recommendations for placing and compacting backfill material. If no recommendations are made, bring the backfill up equally inside and outside the bins as follows:

For backfill material outside the bins, use roadway excavation and place it as specified in Subsection 203.03.2(B).

Furnish backfill material for inside the bins meeting Subsection 701.09 requirements.

Place the backfill in 8-inch (205 mm) maximum compacted lifts, completely filling in all corrugations. Compact backfill as specified in Subsection 203.03.3. Hollow sounding corrugations in the bin wall face detected by the Inspector is cause to remove, replace, and re-compact the backfill at Contractor expense.

614.04 METHOD OF MEASUREMENT.

614.04.1 Concrete. Concrete is measured by the cubic yard (cubic meter) under Subsection 552.04.

614.04.2 Reinforcing Steel. Reinforcing steel is measured by the pound (kilogram) under Subsection 555.04.

614.04.3 Metal Retaining Walls. Metal bin-type retaining walls are measured by the nominal square foot (square meter) of facial area of wall.

614.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made as follows:

Pay Item	Pay Unit
Concrete	Cubic Yard (cubic meter)
Reinforcing Steel	Pound (kilogram)
Metal Retaining Wall	Square Foot (square meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 616
CONDUITS AND PULL BOXES

616.01 DESCRIPTION. This work is furnishing and installing plastic and steel electrical conduit, including fittings, junction boxes, pull boxes, and accessories.

616.02 MATERIALS. Furnish materials meeting the following requirements:

Conduit	Subsection 703.02
Pull Boxes	Subsection 703.03

616.03 CONSTRUCTION REQUIREMENTS.

616.03.1 General. Install conduit and pull boxes meeting the National Electric Code (NEC) requirements.

Conduit lengths in the Contract are estimated, and may require changes, approved by the Project Manager, to avoid underground obstructions. Refer to Subsection 107.18 regarding locating of underground utilities before excavation.

Provide the specified conduit size, or substitute a larger size conduit at Contractor expense. Do not change conduit size within any conduit run. Use minimum 2-inch (53 mm) diameter conduit between pull boxes and adjacent standard bases.

Install pull boxes and conduits as specified with the pull box covers flush with the concrete facing or as directed.

Compact backfill material for conduit trenches constructed outside of the roadbed sections to the density of the adjacent material.

Restore existing surfaces disturbed by conduit or pull box installations to the original type and condition.

616.03.2 Plastic Conduit. Excavate trenches for plastic conduit a minimum 24-inches (610 mm) deep. Tamp the trench bottom and bed with 2-inches (50 mm) of sand before laying the conduit. Once the conduit is placed, place and compact sand, or soil free of rocks or hard lumps, 6-inches (155 mm) above the pipe. Complete the backfill using material passing a minus 3-inch (75 mm) screen.

Join conduit using a solvent-welded slip-fitter coupling to provide a watertight joint.

Separate plastic parallel and perpendicular conduit runs from each other with at least 3-inches (75 mm) of sand or soil cushion. Cap open ends of conduit to prevent moisture, dirt, or rocks from entering the conduit.

Terminate plastic conduit runs at least 9-inches (230 mm) from the pullbox or foundation with a plastic threaded adaptor. Thread a rigid steel conduit bend into the adaptor for the pullbox or foundation entry. Use insulated bushings and electrically bond the steel conduit ends.

For plastic conduit runs 300 feet (91 m) or longer, leave one end disconnected or insert an "O" ring expansion coupling near one end of the run.

616.03.3 Steel Conduit. Install rigid conduit meeting the National Electrical Code Article 346.

Use the size and type of conduits and fittings specified in the Contract.

Make field cuts square and true so that the ends will join full circumference. Ream the conduit ends to remove burrs and rough edges.

Slip joints or running threads are not permitted for coupling conduit. Use an approved threaded union coupling when a standard coupling cannot be used.

Coat any new threads on conduit with a cold galvanizing compound before making couplings.

Tighten couplings until the conduit ends are brought together making a good electrical connection throughout the entire conduit run.

Paint damaged conduit coating with a cold galvanizing compound.

Thread and cap conduit with standard pipe caps until the wiring is placed. Install insulated grounding bushings when caps are removed.

Terminate conduit in standard or pedestal foundations at least 3-inches (75 mm) from the foundation top. Keep conduit within foundations at least 6-inches (155 mm) from the foundation face.

Have conduit enter the foundation at least 24-inches (610 mm) from the top. Conduit stubs on structures are specified in the Contract. Paint conduit stubs, caps, and exposed threads with rust-preventative paint.

Mark the conduit end locations in structures and at curbs directly above the conduit end by cutting a minimum 3-inch (75 mm) "Y" into the curb face, gutter, or wall.

Make conduit field bends having a minimum radius of six times the inside diameter of the conduit. Factory conduit bends must not crimp or flatten the conduit and use the longest practical radius.

Place and securely hold in position conduit ends, anchor bolts, and other fittings set in concrete until the concrete sets.

Lay conduit a minimum of 18-inches (460 mm) below the curb grade in sidewalk areas and not less than 24-inches (610 mm) below the finished grade in all other areas.

Install conduits under railroad tracks to railroad company requirements. Notify the Department and the railroad company at least 48 hours before starting work on railroad property.

Place conduits installed under an existing roadway as specified.

Jack or drill conduits without damaging the roadway surface.

Open cut highways only if other methods have failed and if approved by the Project Manager. The Project Manager may approve cutting small test holes in the roadway surface to locate obstructions. Keep jacking and drilling pits at least 2 feet (610 mm) away from the roadway surface edge. Do not undermine the roadway surface or soften subgrade when using water.

When approved by the Project Manager, trench across paved roadways without disturbing or injuring the paved surface on both sides of the trench.

Cut asphalt pavements leaving a straight cut face. Excavate, install conduit, and backfill with approved material. Fill the top 1 foot (305 mm) of the trench with compacted plant mix or as directed. Replace all damaged pavement.

Compact backfill material in the roadbed section to at least 95 percent of maximum density at optimum moisture content meeting Subsection 203.03.3 requirements.

Extend conduit terminating in standards or pedestals above the foundation and slope it towards the handhole opening. Terminate conduit entering concrete pull boxes 2-inches (50 mm) inside the box wall, at least 2-inches (50 mm) above the bottom, and slope it to aide cable pulling. Locate conduit entrances in pull box bottoms near the end walls leaving most of the box clear. Install conduit outlets in the box from the direction of the run. Seal conduit leading into socket walls, lights, or fixtures below the pull box grade using a watertight sealing compound.

Install a pull wire in all unused conduits over 10 feet (3 m) long. Double at least 2 feet (610 mm) of pull wire back into the conduit at each termination point for runs over 100 feet (30.5 m); double 1 foot (305 mm) back for shorter runs.

Install a conduit expansion joint, detailed in the Contract, where the conduit crosses a fixed or structure expansion joint. Equip each expansion fitting with a grounding strap jumper. Thoroughly clean contact areas before clamping grounding straps.

Secure all conduit bonds, lighting bracket anchor bolts, and bridge rail anchor bolts to form a continuous mechanical and electrical system.

Clean out existing underground conduit incorporated into new conduit with compressed air and mandrel for size if required.

616.03.4 Pull Boxes and Manholes. Construct and install pull boxes and manholes as specified. The Contractor may install additional pull boxes to aide the work at its expense. Install pull boxes and manholes with covers level with curbs, sidewalks, and surrounding ground. Bed the box bottoms in concrete or crushed rock as specified.

616.04 METHOD OF MEASUREMENT.

616.04.1 Lump Sum. No measurement is made for conduit systems when the Contract specifies payment on a lump sum basis.

616.04.2 Unit Basis. Measurement for conduit systems specified in the Contract for payment on a unit price basis are made as follows:

A. **Conduit.** Conduit is measured by the linear foot (meter) to the nearest 1 foot (0.1 m).
B. **Manholes and Pull Boxes.** Manholes and pull boxes are measured by the unit.

616.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Conduit	Lump Sum
Conduit	Linear Foot (linear meter)
Manholes	Each
Pull Box	Each

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 617
TRAFFIC SIGNALS AND LIGHTING

617.01 DESCRIPTION. This work is installing or modifying of traffic signal(s), lighting, and other electrical systems.

617.02 MATERIALS. Furnish materials meeting the following requirements:

Lighting and Signal Materials	Section 703
Paints	Section 710
Class "D" Portland Cement Concrete	Section 551

617.03 CONSTRUCTION REQUIREMENTS.

617.03.1 General. Obtain daily, safety circuit clearance from the servicing utility before starting work on existing series street lighting circuits. Pull cut-out plugs and place worker signs at cut-out boxes before work is started.

Pick up State-furnished material and equipment from the Department of Transportation, Traffic Engineering Section, 2701 Prospect Avenue, Helena, Montana, and transport to the project as part of the contract unit price. Provide the Traffic Engineering Section at least 48 hours advance notice before arriving to take delivery.

Repair or replace all existing improvements and equipment disturbed, damaged, or removed in performing the work at Contractor expense.

The locations in the Contract for signal and light standards, controller pedestals, conduit runs, pull boxes, illuminated signs, and appurtenances are approximate. The Project Manager will establish the exact field locations.

Furnish and install all incidental parts not specified but necessary to complete or modify the traffic signal, lighting, or other electrical systems at Contractor expense.

Make arrangements with the serving utility for providing service to the project.

Pay all fees and energy costs up to the time the project is accepted. The Department will pay for the energy costs to operate signals and lighting for public benefit, when ordered by the Project Manager.

All systems must be complete and operable when the work is completed.

See Section 703 for additional construction requirements.

617.03.2 Equipment Lists and Drawings. Submit within 60 calendar days of award, the following to the Project Manager for approval:

1. A complete list of the proposed equipment and material. Include the quantity, description, size, name of the manufacturer, and catalog number of each item.
2. Ten copies of the manufacturer's catalog sheets for each item of equipment and material listed. The catalog sheets must have the specific items to be used underlined in red include item specifications.
3. Ten copies of the shop drawings, design calculations, and welding procedures for all metal signal and luminaire standards. Check and approve the shop drawings and design calculations before submitting to the Project Manager. Show Contractor approval on the drawings.

The Department has 20 Working Days to approve the submittal's. Upon receipt of the approved list of equipment and material, immediately order the materials and

submit to the Project Manager copies of the dated purchase orders for major items. Re-submit any disapproved items for Department review within 20 working days of notification of disapproval.

Submit to the Project Manager copies of the invoices showing the shipping date(s) within 30 calendar days of the invoice dates.

The calendar date or the number of working days allowed for completion of the Contract will be adjusted by the number of days the Department's review of submittal's overrun the Department's review time.

Furnish for approval, 4 copies of the wiring diagrams for the controller cabinets and ten copies of the certified mill test reports for pole material. In lieu of certified mill test reports, provide the manufacturers certification that pole material and galvanizing meets specifications.

The Department is not liable for any material purchased, labor performed, or work delay (except as stated above) before approval of the required submittal's.

All material is subject to inspection after delivery to the project and during installation on the project. Failure by the Project Manager to note defective material or faulty workmanship during construction does not relieve the Contractor of responsibility for removing or replacing defective material or redoing work at its expense. Inspection or sampling of certain materials may be made at the factory or warehouse before delivery to the site at the Project Manager's discretion. No material rejected before delivery, is to be delivered to the project, and all material rejected on the project must be removed from the work.

Submit all equipment guaranties and warranties to the Project Manager.

617.03.3 Maintenance of Signals. Maintain existing traffic signals that are moved or modified once work begins.

The agency normally responsible for existing traffic signals will continue that responsibility until work begins.

Be responsible for new or modified traffic signals placed in service until the project is accepted. Provide in writing the names and phone numbers of the persons responsible for the operability and maintenance to the jurisdictional law enforcement agency and the Project Manager in case of signal malfunction.

617.03.4 Excavating and Backfilling. Excavate for conduit, foundations, other equipment and materials as specified. Excavate trenches to the width necessary to install electrical equipment, materials, and foundations. Saw cut all existing pavements before excavating.

Do not start excavation until the conduit, equipment, and materials are on site.

Place excavated material without obstructing vehicular or pedestrian traffic or surface drainage. Remove and dispose of surplus excavated material at the end of each workday.

Backfill excavations meeting Subsection 209.03.6 requirements. Bring excavations up level with the adjacent surface or grade to drain as required until permanent repairs are made.

When construction is suspended each day, clear all equipment and material from the roadway for public use as specified in Section 618.

Restore sidewalks, pavement, and landscaping at each intersection before starting work at other intersections. Restrict only one traffic lane for excavations in streets and highways at any time, following the approved traffic control plan.

617.03.5 Removing and Replacing Improvements. Replace or re-construct existing sidewalks, curbs, gutters, pavement, bituminous surfacing, base material, and other improvements removed, broken, or damaged by the Contractor with equal or better quality materials.

Cut concrete sidewalk and pavement borders to be removed without damaging the adjacent surface. Whenever a part of the existing concrete sidewalk, driveway or pavement is broken or damaged, remove the entire square or slab and replace the concrete as specified.

Repair or remove and replace all existing improvements damaged by the Contractor at its expense.

617.03.6 Foundations. Construct post, standard, controller cabinet, and pull box concrete encasing pad foundations using Class "D" portland cement concrete meeting the applicable requirements of Section 551.

Place the concrete foundation bottoms on undisturbed ground. Mono-lithically pour foundations where practical. Form the exposed faces. Assure forms are rigid and braced true to line and grade. Finish the footing tops for posts and standards, except special foundations, to the curb or sidewalk grade or as directed. Position and hold in place conduit ends and anchor bolts using a template until the concrete has set.

Apply an Ordinary Surface Finish to the exposed concrete surfaces meeting Subsection 552.03.12 (A).

Where obstructions prevent the construction of planned foundations, the Contractor may propose an alternate foundation construction method.

Posts, poles, standards, and pedestals may be erected, plumbed and raked after the foundation concrete has cured at least 72 hours.

617.03.7 Conductors and Wiring. Install wiring meeting the National Electric Code requirements.

Neatly arrange and lace wiring in cabinets, junction boxes, and the like.

Run conductors in conduit except inside poles. Remove all dirt and moisture from the conduit runs before pulling wiring. Use powdered soapstone, talc, or other approved lubricant when placing conductors in conduit.

Run signal light conductors without splices from a terminal block located in the cabinet, compartment, or signal head to a similarly located terminal block.

Splice conductors only where specified using approved watertight connectors.

Locate connectors in pole bases to be easily accessible through the handhole.

Leave at least 2 feet (610 mm) of slack for each conductor at each standard and pull box.

Use a conductor separate from the signal light circuit for all 24-volt circuits, such as pedestrian push-button circuits.

When conductors and cables are pulled through conduit, tape the conductor and cable ends to seal out moisture until the splices are made or terminal appliances attached. Tape the ends of spare conductors.

Tag cables at controller cabinets and poles to show routing. Provide color-coded wire diagrams for individual wire routing.

617.03.8 Span Wire-Mounted Signals. Install span wire suspended signals on overhead guys providing a sag of 5% of the total span distance.

Raise overhead guys with the signals attached, to the specified sag. Adjust the guy mounting height at either or both poles, or the sag, or the rake of steel poles so that the signals are at the specified height with the proper sag and the poles are plumb when completed. Do not pull guys beyond the specified sag.

617.03.9 Bonding and Grounding. Make metallic cable sheaths, conduit, and metal poles and pedestals mechanically and electrically secure to form a continuous grounded system. Use copper wire or strap of equal cross sectional area to a AWG No. 6 conductor for bonding and grounding jumpers. Use a No. 6 copper bonding strap, to bond standards and pedestals, attaching it to an anchor bolt and all conduit. Use a bare copper AWG No. 6 solid wire connected between the grounding lug on the standard or pedestal and the bonding strap. Ground one side of the secondary circuit of series-multiple transformers.

Ground conduit and neutrals at service points meeting the Electrical Code or this Section, except that AWG No. 6 conductor or equal shall be used for grounding.

Furnish and install nonferrous ground rods or approved equals of at least 5/8-inch x 8 feet (16 mm X 2.4 m) at each service point. Install ground rods meeting the Contract and Code requirements. Bond the service equipment to the ground rod using a ground clamp and a bare AWG metal No. 6 solid copper wire or equal enclosed in a 3/4-inch (21 mm) diameter schedule 80 plastic conduit.

617.03.10 Service Connections. Service pole locations shown in the Contract are approximate. The Contractor, Project Manager and serving utility will jointly determine the exact locations. The utility will specify the riser location when the Contractor is to install the lower section of a riser on a utility pole.

617.03.11 Conduit and Pull Boxes. Refer to Section 616.

617.03.12 Painting. Perform painting meeting Section 612 requirements.

Clean standards, frames, signal bridges, fittings, and other metal parts to be painted following the paint manufacturer's recommendations before applying paint.

Apply two coats of cold galvanizing compound to breaks, abrasions, and damaged galvanized surfaces. Undamaged, shop-coated metal parts do not require field priming.

Prepare galvanized surfaces to be painted following the paint manufacturer's recommendations or as follows if no recommendations are made:

Dissolve 2 ounces (59 mL) each of copper chloride, copper nitrate, and sal ammoniac in 1 gallon (3.8 L) of water in a glass container. Add 2 ounces (59 mL)

of commercial muriatic acid. Apply the solution to the galvanized surface with a wide, flat brush.

Apply one coat of primer after the surface develops a grey film.

Spot coat damaged surfaces with primer, once installed.

Apply two coats of enamel of the color specified below.

Factory-enamelled signal heads and fittings of black or dark olive-green in good condition will not require painting. Apply one coat of primer and two coats of enamel to signal heads that are un-painted or when directed.

Like components for the same intersection shall be the same color.

Apply one coat of primer to the backplates.

Apply two coats of flat black enamel to hood interiors and front faces of backplates.

Factory-enamelled controller cabinet exteriors in good condition do not require painting. Paint unpainted cabinet exteriors with one coat of primer and two coats of aluminum enamel.

Galvanized poles will not require painting except for repairing damaged surfaces.

Apply paint by hand brushing or spray equipment. The Project Manager will require brush painting if spraying produces unsatisfactory results.

617.03.13 Field Test. Conduct the following tests on traffic signal and lighting circuits with the Project Manager present before completing the work.

1. Test each circuit for continuity;
2. Test each circuit for grounds;
3. Perform a megger test on each vehicle detector loop between the loop and ground before and after sealing. The megger readings must exceed 10 megohms;
4. A functional test that demonstrates the system functions as specified.

617.03.14 Salvaging and Reinstalling Electrical Equipment.

A. **Salvaging Electrical Equipment.** Remove, clean, salvage, and stockpile or re-install existing electrical equipment as specified.

Underground conduit, conductors, and foundations not reused are the Contractor's property and must be removed. The materials may, with written approval, be abandoned in place.

Replace all electrical equipment damaged or destroyed during salvage operations at Contractor expense.

B. **Reinstalling Salvaged Electrical Equipment.** Furnish and install all necessary materials and equipment to complete the new installation.

617.04 METHOD OF MEASUREMENT.

617.04.1 Lump Sum. No measurement for payment is made.

617.04.2 Unit Basis. Measurement is as follows:

1. Conduit and pull boxes are measured under Subsection 616.04.2 (A) (B).
2. Concrete foundations are measured by the cubic yard (cubic meter) based on plan dimensions. Deductions are not made for the concrete displaced by

reinforcing steel, anchor bolts, and conduit. Foundation work includes backfill, furnishing reinforcing steel, electrical bonding, and restoring the surface around the foundation.

3. Cables, conductors, and treated timber poles are measured by the linear foot (meter) to the nearest foot (0.1 m), in place.
4. The following items are measured by the unit:
   - Standards
   - Controller Cabinet Pedestals
   - Controllers
   - Luminaire Assemblies
   - Service and Control Assemblies
   - Photoelectric Controls
   - Traffic Signals
   - Pedestrian Signals
   - Signal Standards
   - Detector Loops
   - Detector Loop Amplifiers
   - Pedestrian Push Buttons
   - Emergency Pre-emption Systems
   - Other component parts as specified in the Contract

617.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

617.05.1 Lump Sum. Payment is at the contract lump sum price.

617.05.2 Unit Basis. Payment is as follows:

Pay Item	Pay Unit
Conduit and Pull Boxes	See 616.05
Concrete	Cubic Yard (Cubic Meter)
Cables	Linear Foot (Linear Meter)
Conductors	Linear Foot (Linear Meter)
Treated Timber Poles	Linear Foot (Linear Meter)
Pull Boxes	Each
Standards	Each
Controller Cabinet Pedestals	Each
Controllers	Each
Luminaire Assemblies	Each
Service and Control Assemblies	Each
Photoelectric Controls	Each
Traffic Signals	Each
Pedestrian Signals	Each
Signal Standards	Each
Detector Loops	Each
Detector Loop Amplifiers	Each
Pedestrian Push Buttons	Each
Emergency Pre-emption Systems	Each
Other Components as specified in the Contract	Each

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract and to furnish and operational system.

SECTION 618
TRAFFIC CONTROL

618.01 DESCRIPTION. This work is the furnishing, installing, and maintaining of traffic signs, barricades, lights, signals, pavement markings, and other specified traffic control devices. It includes flagging and pilot car operation and furnishing and applying water for dust control.

618.02 MATERIALS. Furnish materials meeting the Contract requirements, the MUTCD, and the following:

Reflective Sheeting	Subsection 704.01.10
Temporary Pavement Marking Tape	Subsection 714.01
Temporary Pavement Marking Tabs	Subsection 714.02
Preformed Plastic Pavement Markings	Subsection 714.03
Traffic Line Paint	Subsection 714.04
Signs and Channelizing Devices	Subsection 715.01
Portable Sign Support Assemblies	Subsection 715.02
Advance Warning Arrow Panels	Subsection 715.03
Warning Lights	Subsection 715.04
Flagger Ahead Warning Signs	Subsection 715.05

618.03 CONSTRUCTION REQUIREMENTS.

618.03.1 Purpose and Prosecution of Work Zone Traffic Control. Schedule construction and provide work zone traffic control to accomplish the following :

1. To provide the protection, safety, and convenience for motorists, pedestrians and for construction personnel protection and safety.
2. To advance the project work in the most beneficial manner to the public.

Provide work zone traffic control for all construction activities on the roadway and within the clear construction zone and other specified areas. The construction clear zone is the area within 30 feet (9.2 m) of the edge of a traffic lane.

Furnish work zone traffic control meeting the Contract requirements, the MUTCD, and the approved traffic control plan.

618.03.2 Traffic Control Plan. A general traffic control plan is included in the Contract. The Contractor may develop and submit an alternate plan for approval.

The Contractor's alternate traffic control plan must address signing, channelization, location and purpose of flaggers, pilot vehicle use, and the travel and merging of hauling units.

Obtain approval of the alternate plan before using it.

618.03.3 Traffic Control Conference. Attend a work zone traffic control conference organized by the Project Manager before starting work that alters the public's use of any roadway. The provisions for traffic control proposed for each stage of construction will be reviewed.

618.03.4 Traffic Control Reviews. Designate personnel to be responsible for traffic control work and its continuous surveillance. The designee(s) must be available 24 hours a day to respond to calls concerning damage to traffic control devices from any cause. Provide the Project Manager, at the preconstruction conference, the name(s) of the person(s) responsible for the surveillance.

The Project Manager and the designee(s) will conduct periodic reviews of the traffic control throughout the work to insure compliance with the traffic control plan. The reviews will be conducted at night, during adverse weather conditions, when construction work is active and inactive, and at other times as necessary.

618.03.5 Traffic Control General Requirements. Meet all traffic control plan requirements before starting work affecting the roadway. Use devices that are new or like new in condition.

Properly maintain, clean, and operate devices when in use. Immediately remove the devices when they are no longer applicable to the work. Cover with opaque material or remove all non-applicable signs from the work.

Remove portable traffic control devices when not in use.

Immediately remove existing signs and other traffic control devices on the present traveled way or on connecting State or Federal routes to be abandoned when they no longer apply. Assure roadways are always appropriately signed. Turn removed signs over to the Department.

Provide functional traffic lanes with signing and channelizing appropriate to the roadway condition at the close of each work day.

Provide the traffic an un-obscured view of the traffic control devices at all times.

Store or park construction equipment, vehicles, materials, and debris at least 10 feet (3 m) behind guardrail or outside the clear zone. When this is impractical, use approved warning devices and protective measures to delineate the item. Only equipment and materials for immediate use or incorporation into the work may be placed within the clear zone.

Store unused traffic control devices outside the clear zone.

Contractor furnished traffic control devices are the Contractor's property. Traffic control devices furnished by the Department or installed on a force account basis are the Department's property.

Repair or replace all damaged traffic control devices at Contractor expense.

If the Contractor fails to provide the required traffic control, the Project Manager will provide the work and deduct the costs from monies due or that may become due the Contractor.

618.03.6 Access Breaks. Submit proposals for temporary breaks in interstate access control or right-of-way fences in writing to the Project Manager for approval.

Access breaks are typically not permitted within 1 mile (1.6 km) of an interchange ramp. Access breaks under 1 mile (1.6 km) may be approved if there are extenuating conditions and the roadway ADT is 750 or less.

Include the following information in the proposal:

1. Intended use of the access break;
2. A sketch showing the location of the proposed access approaches and sight distances;

3. The proposed traffic control. Standard traffic control layout drawings may be used with an area sketch and the stations noted;
4. Security measures for access and right-of-way control;
5. A Contractor statement attesting that the Contractor assumes full liability for area restoration, including the access or right-of-way controls;
6. Any other information pertinent to the use of the access break.

618.03.7 Crossing, Entering, and Using Roadways.

A. General. Construct temporary approaches and crossings with 10:1 side slopes and include drainage provisions.

Remove all temporary approaches and median crossings once the work is complete. Restore and re-seed disturbed areas.

Do not use areas within the right-of-way as borrow sources or disposal areas for the construction or restoration of temporary approaches.

Operate hauling units with the flow of traffic. Do not operate hauling units on roadway shoulders.

B. Limited Access and Multiple-Lane Roadways. Use frontage roads and interchanges for equipment access to the interstate roadway whenever possible.

Do not stop the general traffic on one-way roadways for the convenience of haul units. Use interchanges or a series of appropriate lane closures at temporary access breaks and median crossings for haul-unit operations on one-way roadways.

Haul unit turning movements are restricted to right-turn movements only, when there is access to the project by frontage roads and where left-turn movements by hauling units would pose a hazard to the travelling public.

Submit temporary median crossing proposals for approval. Include the applicable information detailed in Subsection 618.03.7.

Temporary median crossings may be permitted subject to the following guidelines:

1. The distance between any two median crossings, including interchanges, authorized vehicle median crossings, and temporary median crossings must be at least 2 miles (3.2 km).
2. Median crossings must be at least 1,000 feet (305 m) from structures and have a minimum 1,500 feet (458 m) of sight distance at 3.5 feet (1.1 M) above the pavement.
3. Sign median crossings as specified in the Contract.
4. When not in use, protect crossings through median barriers by one of the following methods:
   a. Place an approved impact attenuator at each end of the barrier opening.
   b. Close the inside lanes to traffic with a controlled lane closure.
   c. Close the opening by replacing and pinning the median barrier.

C. Two-Lane Roadways. Always provide at least one functional lane for traffic.

Meet Table 618-1 requirements.

TABLE 618-1
TRAFFIC CONTROL REQUIREMENTS FOR HAULING UNITS ENTERING OR CROSSING 2-LANE ROADWAYS

ADT/LOAD FREQUENCY	TRAFFIC CONTROL REQUIREMENT
Less than 2000 ADT	Stop hauling units for traffic.
2000 to 5000 ADT/Less than 50 loads per shift.	Stop hauling units for traffic.
2000 to 5000 ADT/More than 50 loads per shift.	Provide Flaggers to control traffic.
More than 5000 ADT	Provide Flaggers to control traffic.

The Project Manager may adjust the ADT or load frequency at which flagging is required in Table 618-1.

Where flaggers are not required by Table 618-1, the Contractor may use flaggers and traffic control, with Project Manager approval at Contractor expense.

Limit the number or locations at which flagging is provided at roadway crossings or entrances to:

1. One location per material or plant site; or
2. The number of locations required by an indicated materials source.

618.03.8 Traffic Control at Drop-Off Areas. Temporarily fill drop-offs within 30 feet (10 m) of the shoulder of lanes used by traffic and not protected by guardrail to a 3:1 slope or flatter at the close of work each day or delineate the drop-offs steeper than 3:1 using vertical panels. Panel spacing is determined using the following formula:

$$\textbf{Spacing in Feet (meters)} = \frac{(A \times C \times W)}{(S \times D)}$$

Where: **A** = Average Daily Traffic Adjustment
C = Degree of Curvature (metric radius factor)
W = Recoverable Width, 4:1 or flatter, from centerline to the drop-off in feet (meters). Measure from the inside edge of the traffic lane on four lane roadways.
S = Posted Speed in M.P.H. (K.P.H.)
D = Average drop-off depth in inches (mm)

Use the following C factor for drop-offs outside of horizontal curves:

Degree of Curve	C	Metric Radius	C
Less than 2°	5800	Greater than 900m	241,000
2° to less than 4°	5200	900m to more than 450m	218,000
4° to less than 6°	4900	450m to more than 300m	203,000
6° or greater	4500	300m or less	188,000

Use the C factor for curves less than 2° curves (greater then 900 m) for drop-offs on the inside of horizontal curves.

Use the following Average Daily Traffic (ADT) adjustment:

ADT	A
Under 750	1.50
750 - 1499	1.30
1500 - 5999	1.00
Over 6000	0.90

Round the computed spacing to the nearest 10 feet (3 m). Do not space panels greater than 390 feet (119 m). Delineate with flexible guideposts or standard delineators spaced at 400 feet (122 m) if computed spacing exceeds 400 feet (122 m).

Use 8-inch (205 mm) by 24-inch (610 mm) vertical panels for computed spacings from 390 feet to 100 feet (119 m to 30 m).

Use 12-inch (305 mm) by 36-inch (915 mm) panels for computed spacings of 90 feet (27 m) or less.

Install panels with the bottom 36-inches (915 mm) above the traveled way surface.

The minimum vertical panel spacing is 40 feet (12 m). Equip alternating vertical panels with Type C steady burn warning lights for computed spacings of 40 feet (12 m) or less.

The Engineer may require installing a positive barrier for computed spacings of 20 feet (6 m) or less if drop-offs will remain un-worked beyond 48 hours.

Maintain 3:1 slopes or flatter where possible. Provide traffic control at Contractor expense for slopes not shaped to 3:1 or flatter where flattening does not impact prosecution of the work.

618.03.9 Traffic Control for Paving and Milling Operations. Provide flaggers at paving and milling machines. Locate the flagger 100 to 150 feet (30 to 46 m) upstream from the machines.

Meet the following requirements for night paving operations:

a. Place a 48 x 48-inch (1,220 X 1,220 mm) "NIGHT PAVING AHEAD" warning sign in advance of each warning sign series;

b. Assure all personnel working on or adjacent to traveled lanes are wearing reflectorized vests or reflectorized exterior clothing. The reflectorized area must be at least 50 square inches (32,260 mm^2) of material visible from any direction.

618.03.10 Temporary Pavement Marking Requirements. Place temporary reflectorized pavement markings or a combination of markings and signs on all sections of newly constructed pavement before opening to traffic. This includes detours, transitions, and all pavement lifts, including friction courses, to be used by traffic.

Use temporary pavement marking tape or tabs or traffic line paint placed under Table 618-3. Meet the signing requirements for no-passing zones specified in note 2 following Table 618-3.

TABLE 618-3
TEMPORARY PAVEMENT MARKING AND SIGNING REQUIREMENTS

Marking Location	Marking Type and Requirements		
	Tabs	Tape	Paint
Centerline - on tangents and curves of 5 degrees and less, Lane lines	3 tabs spaced 2' (610 mm) apart placed every 40' (12.2 m) (4' in 40') (0.6 in 12.2 m)	4" x 4' (102 X 1219 mm) segments placed every 40' (12 m) (4' in 40') (0.6 in 12.2 m)	4" x 4' (102 X 1219 mm) stripe painted every 40 '(12.2 m) (4' in 40') (0.6 in 12.2 m)
Centerline - on curves 5 degrees and greater	3 tabs spaced 1' (305 mm) apart placed every 20' (6.1 m) (2' in 20') (0.6 in 6.1 m)	4" x 2' (102 X 610 mm) segments placed every 20' (6.1 m) (2' in 20') (0.6 in 6.1 m)	4" x 2' (102 X 610 mm) stripe painted every 20' (6.1 m) (2' in 20') (0.6 in 6.1 m)
Centerline - No Passing Zones	Not Used (See note 2)	Solid double 4" (102 mm) strips or 4" x 2' and (102 X 610 mm) 4" x 4' segments (102 x 1219 mm) plus signing (See notes 1 & 2)	Solid double 4" (102 mm) painted stripes or 4" x 2' (102 X 610 mm)and 4" x 4' painted (102 X 1219 mm) stripes plus signing (See notes 1 & 2)

NOTES:

1. Use 4" x 2' (102 X 1220 mm) tape segments or paint stripes placed every 40'(12.2 m) on tangents and curves of 5 degrees and less. Use 4" x 2' (102 X 1220 mm) tape segments or paint stripes placed every 20 feet (6.1 m) on curves of 5 degrees and greater.
2. Use No-passing zone signing consisting of one 48 x 60-inch (1220 X 1525 mm) "DO NOT PASS" (R4-1) placed on the right-hand side of the roadway at the beginning of each zone and one 48 x 60-inch (1220 X 1525 mm) "PASS WITH CARE" (R4-2) placed at the end of each zone. Use 24 X 30-inch (610 mm X 760 mm) only with the Project Manager's approval.
3. Use White tabs, tape, and paint on all one-way multi-lane roadways. Use yellow on all 2 lane roadways.
4. Apply paint striping, including application rates meeting Section 620 requirements.
5. Remove all temporary pavement markings that conflict with interim or final pavement markings at Contractor expense.
6. For Seal Coat operations, place 4 equally-spaced tabs over existing 10 foot (3 m) centerline stripes.
   A. **Temporary Pavement Markings.** Temporary pavement markings may be used for a maximum 3 calendar days on pavements under traffic. Place final centerline marking and lane line stripes meeting Section 620 requirements after the 3 day period. The Project Manager will suspend paving operations if the final striping is not applied by the end of the 3 day period.

If the final striping is not applied within 10 calendar days after the temporary striping was applied, the Project Manager may have the work performed deducting all costs from monies due or that may become due the Contractor.

B. **Interim Striping.** Before seasonal suspension of work, stripe newly constructed pavements, including partially completed sections, meeting Section 620 requirements. The striping includes centerline with no-passing zone controls, lane lines, and shoulder lines.

618.03.11 Traffic Control For Seal Coat Operations.

A. **Two-Lane Two-Way and Multiple-lane Two-Way Roadways.** Control traffic with pilot cars for the first 48 hours, or longer as directed, after the seal coat is applied. The 48 hours begin at the end of the Contractor's work shift in each six mile (9.6 km) section.

The Department will pay for all pilot cars, flaggers, signs and devices used for the initial 48 hours of pilot car operation on each 6 consecutive roadway miles (9.6 km) of seal and cover work and on any remaining section less than 6 miles (9.6 km).

Pilot car operation beyond 48 hours, unless ordered by the Project Manager, is at Contractor expense.

Pilot car use may be discontinued after 48 hours if temporary pavement markings or final centerline marking are in place.

Place pavement markings on centerline, including no-passing zone controls, and lane lines within 3 calendar days of terminating pilot car use within each 6 mile (9.6 km) or fractional section.

Liquidated Damages will be assessed at $500.00 per day for each two lane traffic mile not striped by the above time limit.

If stripping is not placed within 7 calendar days the Department will have the work performed and deduct the costs from monies owed the Contractor.

Ceasing pilot car use is the end of the initial 48 hours of pilot car operation or when its terminated by the Project Manager.

Place "LOOSE GRAVEL" (W8-7) signs, each with a 30 x 30-inch (760 X 760 mm) advisory speed plate "35 MPH" (W13-1), at each end of each work zone. Place the same sign combination for each direction of travel at 2 mile (3.2 km) intervals within the work zone. Leave the signs in place until all sweeping and striping within the zone are completed.

Place additional work zone signing when sweeping work is performed outside the flagger and pilot car area.

B. **Interstate Highways.** Use lane closures and lane control for seal coat operations on interstate highways. Pilot car operations are not allowed unless otherwise specified.

Meet the "LOOSE GRAVEL" and "35 MPH" sign requirements as specified for two-way roadways. Sign both sides of the roadway.

Place final pavement markings meeting Section 620 within 3 days of completing seal coat operations.

618.03.12 Traffic Control For Striping Operations. Provide the following traffic control for striping operations.

A. Furnish a shadow vehicle to follow the pavement striping vehicle within 500 to 1000 feet (152 to 305 m).

B. Equip shadow vehicles with an arrow board facing rear-approaching traffic.

C. On multiple-lane roadways place the arrow board display in the sequential arrow mode (lane shift).

D. On two-lane two-way roadways place the arrow board in a hazard warning mode not displaying the lane-shift mode.

618.03.13 Traffic Control Device Location and Installation. Lay out the standard distances for traffic control devices to within an accuracy of plus or minus 5%. The Project Manager may direct adjustments to the device locations to fit site conditions.

Display all signs with the legend not more than 5 degrees (1 inch per foot) (25 mm per 305 mm) from the horizontal plane.

Display the signs at the required mounting height with the hinged signs closed or non-hinged signs removed when not applicable.

Use only one type of reflective sheeting in each sequence or group of signs or devices.

Stabilize sign trailers to prevent movement by wind or passing vehicles.

Assure the G20-1 ("ROAD CONSTRUCTION NEXT (X) MILES) and G20-2 (END CONSTRUCTION) signs do not conflict with other construction signing. Remove these signs when directed.

Post-mount work zone traffic control devices to remain at the same location for more than 3 consecutive days. Trailer-mounted W20-7a (flagger ahead) signs with generators are excluded from this requirement.

Install work zone traffic control devices sequentially toward the work area beginning with the device located farthest from the work area. Remove sequentially in the opposite direction.

Use arrow boards in the sequential or flashing-arrow mode to supplement channelizing devices and standard signing when one or more lanes of a multiple-lane roadway are closed.

Do not use arrow boards in the sequential or flashing-arrow mode for lane closures or at flag stations on two-lane two-way roadways.

Do not use flexible guide posts in place of the specified hazard identification devices for shoulder drop-offs or other hazards adjacent to the travel lanes. Refer to Subsection 618.03.8.

Flexible reflectorized warning signs are acceptable for daylight hour use.

Do not use traffic cones for channelization devices.

Do not use steel barrels for work zone traffic control.

618.03.14 Flagging Operations. Provide flaggers that are competent and equipped as required in the Department's booklet "Flaggers Handbook" furnished by the Department.

Maintain constant radio contact between flaggers at each end of a work zone and pilot vehicles when visual contact is not possible. Use two-way V.H.F. or U.H.F. FM radios, operable in the terrain.

Place the W20-7a (flagger ahead) warning sign signals so they are visible 2,000 feet (610 m) in advance of the sign. Place and operate the sign only when a flagger is at the flag station.

Use reflectorized flagger devices and garments for night work. Furnish lighting that makes the flaggers clearly visible from 500 feet (153 m).

Provide a second flagger when more than 10 vehicles are stopped at a flag station 50% of the time to advise traffic of the delay. Place an additional W20-7a sign 500 to 1000 feet (153 to 305 m) ahead of the average end of the stopped vehicle line.

618.03.15 Pilot Car Operations. Use pilot cars as specified. Equip the cars with amber flashing lights, flags, and the G20-4 sign designated in Part VI of the MUTCD. Mount the sign in a conspicuous position on the vehicle with the bottom sign edge at least 6 feet (1.8 m) above the ground.

Schedule and cycle pilot vehicles to depart each flag station at maximum 15 minute intervals.

618.03.16 Water For Dust Control. Furnish and apply dust control water as required.

618.04 METHOD OF MEASUREMENT. The estimated Contract quantities for traffic control devices, temporary pavement markings, flagging, and pilot car operation are an estimate only and may vary from the actual quantities used or required in the Contract. No additional compensation is considered or allowed due to these quantity differences.

618.04.1 Traffic Control Devices. Traffic control devices are measured by the units of traffic control devices used and accepted. A unit of traffic control device is the base value used for establishing the relative value of each type of traffic control device. The relative value of each traffic control device in units is shown in the "Traffic Control Rate Schedule" included in the Contract.

Signs and devices must be in new or like-new condition to be measured for payment.

618.04.2 Temporary Pavement Markings. Temporary pavement markings are measured by the mile (kilometer) to the nearest 0.1 mile (0.16 km) for each application of markings. Only one application of temporary pavement markings is measured for payment on any one lift of pavement at the same location.

One mile (1.6 km) of temporary pavement markings consist of either 1 mile (1.6 km) of centerline striping or 1 mile (1.6 km) of lane line striping between any 2 lanes of a two-lane or multiple-lane roadway.

Temporary pavement marker tabs installed during seal and cover operations are not measured for payment.

No-passing zone signs used in combination with temporary pavement markings are measured separately as traffic control devices.

No-Pass zone signs required after the initial 48 hours of pilot car operation are not measured for payment.

Interim and final striping is measured under Section 620.04.

618.04.3 Flagging. Flagging is measured by the hour for the actual number of approved flagging hours provided on the project by each flagger used.

Travel time for flaggers to and from the project is not measured for payment.

618.04.4 Pilot Car Operation. Pilot car operation is measured by the hour for the approved number of hours of operation for each properly equipped pilot car.

618.04.5 Water For Dust Control. Dust control water is measured by the 1000 gallon (3785 L) units used and accepted. This quantity is converted to units of traffic control by multiplying the quantity by the relative value in units per M Gallon (Kiloliter) units shown in the "Traffic Control Rate Schedule".

Measurement will be by an approved meter or load counter or by manual count of the number of loads of a known quantity applied on the roadway.

No measurement is made of water used on haul roads or for dust conditions that, in the Project Manager's opinion, are not detrimental to the traveling public.

618.04.6 Items Not Eligible For Separate Payment. The following items are not measured or paid for separately.

1. Amber flashing or strobe lights on equipment, vehicles, and hauling units.
2. Impact attenuators for median barrier openings.
3. Permits and costs relating to project access.
4. Construction, drainage, maintenance, removal, restoration and reseeding of areas used for temporary roads, approaches, and crossovers.
5. Radios for flaggers and pilot vehicles.
6. Illumination of flag stations and work areas.
7. Reflectorized safety equipment, garments, and headgear.
8. Vehicle-mounted arrow boards on stripers and shadow vehicles.
9. Replacing temporary pavement marking tabs and tape destroyed by traffic.
10. Temporary pavement marking tabs used for seal coat operations.
11. Costs to clean and maintain installed traffic control devices.
12. Covering or removing non-applicable signs or signs not in use.
13. Other miscellaneous materials and equipment required for proper traffic control that are not included in the "Traffic Control Rate Schedule".

618.05 BASIS OF PAYMENT.

618.05.1 Traffic Control Devices. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Traffic Control Device	Unit
Temporary Pavement Marking	Mile (kilometer)
Flagging	Hour
Pilot Car	Hour
Water	Unit

Traffic control devices are paid for at the contract unit price per unit of traffic control devices. The units of each type of traffic control device paid for are

calculated by multiplying the measured quantity of each device by the value in units per each unit shown in the traffic control rate schedule.

Payment for traffic control devices is made for each setup directed by the Project Manager.

Replacing properly installed traffic control devices destroyed by traffic is paid for at the contract unit price per unit of traffic control devices.

Flexible guide posts for plant mix paving, placing asphalt mix leveling courses, and cold milling operations are paid for at the full rate on a day-by-day basis for each lift of each traffic lane with work underway. Guide posts placed beyond 1,500 feet (458 m) of the work termination point for that day are not eligible for payment.

Payment for barricades and drums includes the required ballast.

Payment for signs mounted on barricades is made only for the original mounting.

Payment for flashing arrow boards is made only for the actual hours of operation approved by the Project Manager. Payment includes the cost of operating the trucks or trailers on which the arrow boards are mounted.

Paint striping removal is paid for at the contract unit price per unit of traffic control devices.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 619
SIGNS, DELINEATORS, AND GUIDEPOSTS

619.01 DESCRIPTION. This work is furnishing, fabricating, erecting, removing, and re-setting signs, delineators, and guideposts.

619.02 MATERIALS. Furnish materials meeting the following requirements:

Signing Material	Subsections 704.01
Guideposts	Subsection 704.03
Delineators	Detailed Drawings

619.03 CONSTRUCTION REQUIREMENTS.

619.03.1 Definitions. The following definitions apply to the signing work in the Contract.

- **A. New.** Signs designated "New" are to be furnished new and erected on new supports at the specified locations.
- **B. Re-use.** Signs designated "Re-use" are to be removed from the existing supports and remounted on new supports at the specified locations.
- **C. Replace.** Signs designated "Replace" are to be removed and replaced with the specified new signs, including new supports, at the existing or specified new locations.
- **D. Replace Sign Face.** Signs designated "Replace Sign Face" are to be removed from the supports and replaced with the specified new signs using the existing supports.
- **E. Use As Is.** Signs designated "Use As Is" are to be left in place.
- **F. Re-set.** Signs designated "Re-set" are to be removed and re-set at the specified locations using the existing sign faces and supports.
- **G. Remove.** Signs designated "Remove" are to be removed, including the sign or sign assembly and sign supports.

619.03.2 Design Calculations and Shop Drawings. Submit a written request for the sign design calculations from the Department's Traffic Section in Helena at least 20 working days before sign fabrication. Make the request for the calculations for the specified guide signs, special design signs, and other signs shown in the Montana Sign and Sign Materials book but not in the FHWA Standard Highway Signs Book.

Submit to the Project Manager, at least 30 working days before sign fabrication, 10 copies of Contractor approved (stamped) shop drawings and welding procedures for sign bridges, and overhead cantilever sign structures. Submit shop drawings on minimum size 11 x 17-inch sheets (A3 paper); welding procedures on 8 ½ x 11-inch (A4 paper) sheets.

The Department has 15 working days upon receipt of the drawings for drawing review. Drawings returned to the Contractor for corrections or additional information must be re-submitted to the Project Manager within 15 working days of receipt.

After the structural steel shop drawings and welding procedures have been reviewed and checked by the Department, all required corrections will be returned to the Contractor who must make the corrections and re-submit 10 copies of the

corrected drawings and welding procedures for final review and approval within 15 days. All final drawings must be stamped "Approved" by the Department before fabrication begins.

Submit 5 copies of shop drawings and current approved weld procedures for tubular sign posts and structural steel sign posts.

The department inspector will compare the drawings and weld procedures to the posts during post inspection at the point of fabrication. Submit weld procedures to the Project Manager for approval every 6 months or whenever they are changed or modified.

Submit shop drawings and welding procedures at one time in a complete package for the Department's initial and subsequent reviews. Individual parts of the submittal's will not be accepted for review.

619.03.3 Fabrication and Erection. Fabricate the signs and sign legends before delivery to the project, except for signs too large to transport in one piece to the project.

Fabricate all signs using the hole spacing specified in the FHWA Standard Highway Signs Book or the Detailed Drawings.

The lengths of poles and steel posts shown in the Contract are estimated lengths. The Project Manager will furnish the required length of each pole and steel post before fabrication is begun.

Locate and erect signs as specified or directed. The Project Manager may change sign locations due to field conditions. Erect signs so the sign face is vertical and aligned as specified. Sign supports must not project above the sign faces.

Jam the threads of the mounting bolts or use vandal resistant nuts for ground-mounted sign faces 25 square feet (2.3 m^2) and smaller. Jam the threads after the sign is installed and adjustments are made.

The specified foundation depth for timber poles is a minimum depth. The Contractor may either field cut the poles to the correct length or bury the extra length to provide the specified mounting.

Excavate or bore foundation holes for sign supports at least 8-inches (205 mm) larger than the largest diameter of post placed in each hole.

Backfill foundation holes for timber posts and poles as follows:

Combine and thoroughly mix the material excavated from the foundation with portland cement using a mix ratio of 10 parts excavated material to 1 part cement. Do not mix in the hole. Add water to make the soil-cement mixture. Place the sign post or pole in the hole without the sign attached. Backfill the hole with the soil-cement mixture in 8-inch (205 mm) maximum lifts. Compact each lift by hand tamping or using mechanical methods. Allow the foundation to cure for 7 days before mounting the sign face to the support.

Foundation holes for wooden sign supports may be backfilled with Class "F" portland cement concrete using the specifications for backfilling foundations for steel sign posts as follows.

Backfill foundations for steel sign posts with Class "A" or "D" concrete finished flush with the adjacent surface. Signs may be post mounted after the concrete has set seven days.

Weld metal joints and post breaks meeting Section 556 requirements.

619.03.4 Inspection. The completed signs will be inspected at the fabricator's plant and on the project before they are installed. Defects including but not limited to cracks, tears, splits, crazing, gouges or curled edges of the background sheeting or legend are cause for rejecting the sign. The installed signs will be inspected at night for nighttime reflectivity and readability. Adjust signs exhibiting specular reflection, as directed.

619.03.5 Sheet Aluminum Overlay. Meet the Contract requirements for sheet aluminum overlays.

Install the sign legend and other components plumb and level. Match the color, shade, and type of existing reflective sheeting used as a background for partial overlays. Fully cover the existing legend and symbols with partial overlay backgrounds. Match the size of the existing sign with complete overlay backgrounds.

619.03.6 Remove and Re-set Signs. Use new materials meeting Section 704 requirements for that required over and above those materials salvaged from signs to be re-set or re-used.

Install breakaway devices on existing posts when specified.

Re-set signs meeting Subsection 619.03.3 requirements.

Repair or replace all Contractor sign damage resulting from dismantling, moving, and re-setting at Contractor expense.

With no exception, remount or re-set within 1 hour all removed warning, regulatory signs and route markers. Re-install guide signs within 5 hours and only during daylight hours. Re-display warning, regulatory, and guide signs by dusk.

Remove foundation material left after removing the existing signs to at least 1 foot (305 mm) below groundline. Fill resulting holes level with the adjacent ground.

Existing signs and supports specified for removal are the Contractor's property. Disassemble and store signs specified to remain the Department's property at the designated location.

Erect the new sign and support before removing the existing sign being replaced. Do not display conflicting signs together. Do not obscure existing signs when placing new signs.

Re-erect existing multiple support signs to be removed and re-set using the original post spacing.

619.03.7 Installation Date Tags and Route Markers. Install date tags and route identification tags on all highway signs before final acceptance.

Meet the Contract requirements for design, color, and installation.

619.03.8 Delineators. Furnish and install delineators as specified at the required locations. Remove delineators conflicting with new construction as specified.

Removed delineators are the Contractor's property and may be re-used, if they are undamaged and meet the Contract requirements.

619.03.9 Guideposts. Install guideposts at the specified locations.

619.03.10 Acceptance. Signs and traffic guide devices are accepted for payment individually or in lots as completed work once installed.

Delineator posts with reflectors are accepted in lots of 100 or more units.

Guide, directional, and warning signs with a surface area of up to 10 square feet (0.93 m^2) on one side are accepted in lots of 25 or more.

Signs with a surface area of up to 30 square feet (2.8 m^2) on one side are accepted in lots of 5 or more.

Overhead structures and signs larger than 30 square feet (2.8 m^2) in sheeting area are accepted individually.

The Department will assume maintenance responsibility for signs and other traffic guide devices once accepted and in place.

Repair or replace signs and devices, at Contractor expense, that are damaged or destroyed by the Contractor's operations.

619.04 METHOD OF MEASUREMENT.

619.04.1 Aluminum and Plywood Signs. Aluminum sheet, aluminum sheet increment, and plywood signs are measured by the square foot (square meter) to the nearest 0.1 square foot (0.1 m^2) of sign face.

619.04.2 Metal Posts. Metal posts are measured by the pound (kilogram). The pay weight is calculated by multiplying the nominal weight per foot (meter) by the installed length of each post plus the weight of the breakaway device, fuse plate, and stub post or foundation embedment. Breakaway systems, bid as a separate item, are measured separately.

619.04.3 Treated Timber poles and posts. Treated timber poles and posts are measured by the linear foot (meter) in even 2 foot (610 mm) increments. When the measurement falls between increments, the measured length for payment is the next higher 2 foot (610 mm) increment.

619.04.4 Delineators. Delineators of each type specified are measured by the unit, including delineator reflector, mounting hardware, and post, complete in place. Removing existing delineators is incidental to other items of the Contract.

619.04.5 Guideposts. Guideposts of each type specified are measured by the unit.

619.04.6 Remove and Re-set Signs. Re-set Signs - Guide and Re-set Signs - Warning, Regulatory, and Route Markers are measured by the unit for each sign removed and re-set in a new location.

Sign groups of 2 or more signs mounted on a single support or multiple supports are measured as a single sign.

When there is not a bid item in the Contract for re-set sign, this work is incidental to other items of the Contract.

619.04.7 Remove Signs. Remove Signs-Guide and Remove Signs - Warning, Regulatory, and Route Markers is measured by the unit for each sign removed including supports.

Sign groups of 2 or more signs mounted on a single support or multiple supports are measured as a single sign.

619.04.8 Replace Signs. New materials for signs designated "Replace" are measured under Subsections 619.04.1, .2, and .3 .

Removal of existing signs designated "Replace" are measured under Subsection 619.04.7.

New materials for signs designated "Replace Sign Face" are measured under Subsection 619.04.1.

619.04.9 Re-use Signs. New material for supports for signs designated "Re-use" is measured under Subsections 619.04.2 and .3 .

Removal of existing signs designated "Re-use" is measured under Subsections 619.04.7.

619.04.10 Sheet Aluminum Overlay. Sheet aluminum for signs designated "Sheet Aluminum Overlay" is measured by the square foot (square meter) to the nearest 0.1 square foot (0.1 m^2) of sign face complete in place.

619.04.11 Lump Sum. When a signing system or portion thereof is specified in the Contract on a lump sum basis, no direct measurement of quantities is made.

619.05 BASIS OF PAYMENT. Payment for the completed and accepted work is made under the following:

Pay Item	Pay Unit
Aluminum and Plywood Signs	Square Foot (square meter)
Metal Sign Post	Pound (kilogram)
Breakaway System	Each
Timber Sign Post	Linear Foot (meter)
Delineators	Each
Guideposts	Each
Remove and Re-set Signs	Each
Remove Signs	Each
Sheet Aluminum Overlay	Square Foot (square meter)
Sign System	Lump Sum

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work, including excavation and backfill, concrete foundation, miscellaneous hardware, welding, date tag and route identification tags and installation under the Contract.

SECTION 620
PAVEMENT MARKING APPLICATION

620.01 DESCRIPTION. This work is the application of temporary, interim and final pavement markings, including lines, words, and symbols. Temporary and interim striping is specified in Section 618.03.10.

620.02 MATERIALS. Furnish materials meeting the following requirements:

Temporary Pavement Marking Tape	Subsection 714.01
Temporary Pavement Marking Tabs	Subsection 714.02
Preformed Plastic Pavement Marking Material	Subsection 714.03
Traffic Line Paint	Subsection 714.04
Reflective Glass Beads	Subsection 714.05
Reflective Thermoplastic Pavement Markings	Subsection 714.06

620.03 CONSTRUCTION REQUIREMENTS.

620.03.1 Layout of Pavement Markings. The Project Manager will furnish the necessary survey notes for the Contractor to establish the horizontal line control for pavement markings.

Establish and maintain pavement marking control lines within 0.25 feet (75 mm) of the true line.

Apply centerline and shoulder lines within 0.30 feet (90 mm) of the true line. Assure the stripe does not deviate more than 0.15 foot (50 mm) in 500 feet (152 m).

The Project Manager will check accuracy as required.

Remove and replace out of specification pavement markings at Contractor expense.

Place other pavement marking as specified in the Contract.

620.03.2 Temporary Pavement Marking Material Application.

A. Pavement Marking Tape and Tabs. Follow the marking manufacturers recommendations for road surface preparation and installation. Assure the surface is clean, dry, and free from excess oil.

B. Preformed Plastic Pavement Marking Materials. Prepare the application surface and apply the marking material following the manufacturer's recommendations.

Apply pavement markings up to 8-inches (205 mm) wide in a single application to the specified width. Apply pavement markings over 8-inches (205 mm) wide in 6-inch or 8-inch (155 or 205 mm) multiple applications and minimum fractional 4-inch (100 mm) applications.

Furnish the marking material thickness specified in the Contract.

Cut and true the marking material edges.

Place inlaid plastic pavement marking materials into the new asphalt pavement just before final compaction and roll it flush with the roadway surface during final compaction.

620.03.3 Painted Pavement Markings.

A. Equipment Requirements. Apply paint and glass beads with equipment manufactured specifically for stripping. Locate the bead applicator directly behind and synchronized with the paint applicator. Shield both applicator's to prevent paint spray or bead loss outside the specified line width.

Apply the stripes within 1/4-inch (6 mm) of the specified width.

The equipment must:

1. Have an automatic skip control to paint a broken-line pattern within 6-inches (155 mm) of each cycle.
2. Be able to paint up to three stripes simultaneously for final stripping (two stripes for temporary).
3. Apply paint at the following rates per gallon (Liter):
   a. 4-inch (100 mm) solid stripe - 250-275 feet per gallon (20-22 m per L);
   b. 4-inch (100 mm) dashed stripe (9-ft stripe/15-ft gap) (2.7 m stripe/ 4.6 m gap)- 665-735 feet per gallon (53-59 m per L);
   c. 4-inch (100 mm) dashed stripe (10-ft stripe/30-ft gap) (3 m stripe/ 9.2 m gap)- 1000-1100 feet per gallon (80-88 m per L).

   Stripes narrower and wider than 4-inches (100 mm) and words and symbols are approximately 88 square feet per gallon (2.2 m^2 per L)

Apply glass beads at 6 plus or minus 0.1 pounds per gallon (.72 plus or minus 0.045 kg per liter).

Equip the pavement marking machine with a flow meter/totalizer that measures paint quantities in gallons (Liters), to the nearest 0.1 gallon (0.1 L). Locate the flow meter/totalizer in the flow line to the spray nozzles at a point where the meter can be easily read from the ground. Assure the calibration adjustment is accessible without meter removal or using a calibration adjustment device.

Introduce glass beads to the paint downstream of the meter.

Calibrate the meter before use on the project and as directed.

Paint may be measured using calibrated paint tanks and measuring devices. Provide the Project Manager calibration certificates from an independent agent for the paint tank and measuring device. Re-certify the tank and measuring device annually. Provide a calibrated container to check against the tank measuring device. The tank will be checked before each use and whenever determined necessary.

Stop bars, crosswalks, and the like may be applied with hand-operated equipment.

Stop stripping work when equipment fails to apply the markings within the specified rates and tolerances until corrected.

B. Surface Preparation and Weather Limitations. Clean the surfaces to be painted following the paint manufacturer's recommendations.

Apply final markings during daylight hours following the paint manufacturer recommendations. Temporary and interim markings may be applied in the evening if approved. Do not apply markings when the minimum air or pavement temperatures are at or below 40 °F (4 °C), the pavement surface is wet, and the weather is foggy, rainy, or inclement. Do not apply markings when the wind prevents obtaining the specified results.

C. **Painting Curbs.** Clean the surfaces following the paint manufacturer's recommendations. Paint the tops and traffic sides of curbs at restricted parking locations as specified.

Apply one uniform coat of yellow traffic line paint to the tops and traffic sides of all island curbs, median curbs, and other similar curbs.

Allow concrete curbs to cure for 30 days before painting.

For estimating purposes, 100 linear feet (30.5 m) of curbing equals approximately 115 square feet (10.7 m^2) of curb surface to be painted.

D. **Striping Open-Graded Friction Course and Seal-Coated Surfaces.** Spray two full applications of centerline and shoulder-line striping.

Apply the second application 30 days or later after the first application on the centerline of two-lane two-way roadways and all transverse lines in the opposite direction of the first application. Apply all other markings in the same direction as the first application.

E. **Marking Protection.** Protect markings until dry. Correct smeared or damaged markings at Contractor expense.

F. **Interim Pavement Marking Quantities.** The paint quantities in the Contract include both interim and final pavement marking applications. The Project Manager will determine if an interim application is needed.

Use paint for the interim application when the final marking specified is a plastic pavement marking.

620.03.4 Temporary Pavement Markings. Place temporary pavement markings meeting Subsection 618.03.10 requirements.

620.03.5 Thermoplastic Pavement Marking Application.

A. **General.** The applicable requirements of Subsection 620.03.2 (B) apply to placing thermoplastic marking material.

B. **Material Acceptance.** Furnish the Project Manager copies of the manufacturer's product specification data before delivering thermoplastic marking material to the project.

Do not place materials not meeting the manufacturer's product specifications.

The Project Manager may request a manufacturer's sample or take field samples at the point of application for testing.

The Department will test samples for one or any combination of the specified requirements.

Remove and replace material represented by failing samples at Contractor expense.

C. **Manufacturer's Instructions.** Submit the manufacturer's instructions for surface preparation and material application before applying thermoplastic.

Include the following:

- Equipment Requirements
- Work Methods and Procedures
- Material Application Temperature Range
- Ambient and Surface Temperature Requirements
- Weather limitations
- Precautions

All other requirements necessary for successful application and satisfactory performance.

Materials supplied without application instructions or with incomplete instructions will not be permitted in the work.

D. Surface and Temperature Requirements. Meet the following requirements unless otherwise recommended by the manufacturer:

1. The minimum allowable ambient air and pavement surface temperature for application is 60 °F (16 °C).
2. The pavement surface, including grooved pavement for inlay applications, must be dry during application.

   The inspector will perform a visual sight and touch inspection that must not indicate dampness. If any question exists concerning the pavement dryness, the following test may be performed. Tape a piece of aluminum foil, roofing paper, or clear plastic wrap to the pavement surface. Wait approximately 15 minutes. Do not apply markings if moisture appears beneath the material.

E. Temperature Monitoring and Heating Equipment. Equip melting and application equipment for thermoplastic material with permanently attached easily read thermometers that provide a true, continuous, representative temperature of the material.

Use an oil bath heating kettle that provides indirect heat to the material to pre-melt the thermoplastic material.

The pre-melting kettles must have rotating agitators that stir the thermoplastic material during heating.

F. Surface Preparation. Follow the manufacturers surface preparation instructions.

G. Primer/Sealer. Follow the pavement marker manufacturer's recommendations for applying primer/sealer. If no recommendations are made, apply a thin, uniform coat of MC-800 on the pavement surfaces and grooved areas to receive the pavement markings.

H. Application. Apply hot thermoplastic marking material to the specified thickness by one or more of the following methods following the manufacturer's instructions.

1. Spraying;
2. Extruding (Top-applied);
3. Extruding into cut or ground grooves (Inlaid).

Apply the extruded thermoplastic to the thickness specified in Table 620-1. Thirty mils (1 mm) of the total applied thickness must project above the finished pavement surface.

TABLE 620-1
THICKNESS OF INLAID THERMOPLASTIC MARKINGS

400 Mils (10 mm)	275 Mils (7 mm)
Words and Symbols	Median Borders
Crosswalks	Continuous Centerline
Stop Bars	Dashed Centerline
8" White Lane Lines	Dashed Lane Lines
Dotted or Skip Lines	Shoulder Lines

Produce thermoplastic markings having straight and uniform edges that adhere to the pavement.

Finish the extruded lines, including words and symbols at least 1/4-inch (6 mm) wider than the groove widths at each edge and within the ranges shown in Table 620-2.

TABLE 620-2
ALLOWABLE MARKING WIDTH/GROOVE WIDTH
TOLERANCE RANGES

SPECIFIED WIDTH	GROOVE WIDTH	FINISHED *MARKING WIDTH
4" (100 mm)	3½" - 4" (90-100 mm)	4" - 4½" (100-115 mm)
8" (205 mm)	7½" - 8" (190-205 mm)	8" - 8½" (205-215 mm)
24" (610 mm)	23½" - 24" (600-610 mm)	24" - 25½" (610-650 mm)

* The finished marking width cannot exceed 1/4-inch (6 mm) wider than the finished width.

Match the FHWA manual "Standard Alphabets For Highway Signs and Pavement Markings" for words and symbols. Produce the markings within 1/4-inch (6 mm) per 4-inches (100 mm) of width.

Use templates for extruding words and symbols that are larger than the grooves and meet the tolerance ranges in Table 620-2 to provide the required edge sealing.

Clean the grooves before placing the thermoplastic material. Meet the surface requirements in Subsection 620.03.5 (D).

Apply thermoplastic material in grooves within 24 hours of grooving.

Keep traffic off the grooves and re-clean them as necessary before applying the thermoplastic material.

I. **Glass Bead Application.** Apply glass beads by drop-on methods immediately after the thermoplastic material application meeting Subsection 620.03.3 (A) requirements.

The minimum glass bead application rate is 6 pounds per 100 square feet (0.30 kg per square meter) of thermoplastic material. The Project Manager may increase the glass bead application rate.

J. **Marking Protection.** Protect the thermoplastic pavement markings from traffic until it has dried as specified in Article 4.3.2 of AASHTO M 249.

K. **Markings - Dimensional Tolerances.** Finish the markings to the specified minimum uniform cross sectional hardened thickness.

Trim lines, words, and symbols to produce sharp, neat lines on all sides and ends.

Meet a linear tolerance of plus or minus 6-inches (155 mm) over each cycle on specified broken-line patterns.

Meet Table 620-2 tolerances for finished line widths.

L. **Joints.** Meet the following for joints in the finished extruded thermoplastic markings:

1. Extrude transverse markings full width with a maximum of one transverse joint per length of line.
2. Apply words and symbols without joints within each symbol, letter, or numeral. Letters made with one or more straight legs (A,L,N,T, etc.) and combination arrows (through and right or through and left, etc.) may be applied with one pass per leg. Combination arrows may be applied with one pass for each arrowhead of the marking.
3. Extrude 4 and 8-inch (100 and 205 mm) longitudinal lines full width in one pass with no transverse joints. Transverse joints are acceptable only for lines exceeding 100 feet (30.5 m) in length and lines shorter than 100 feet (30.5 m) that require a change of direction in the application equipments path.
4. Extrude lines 24-inches (610 mm) wide full width in one pass with a maximum of one transverse joint per length of line.

Finish joints to form neat lines without gaps or unevenness and that are moisture proof.

M. **Patching and Repairing.** Use material from the same batch of thermoplastic material used in the original work.

The patching or repair may be performed mechanically or manually. Re-apply beads as specified. Meet all specified dimensional tolerances and match the original lines.

N. **Cleaning and Trimming of Markings.** Remove irregularities in finished markings without chipping, cracking, or otherwise damaging the markings or causing delaminations or separations between the pavement and thermoplastic material. Follow the manufacture's recommendations for cleaning and trimming of the markings. Do not damage the pavement or thermoplastic material.

620.03.6 Pavement Marking Removal. Remove existing temporary and final pavement markings as specified.

The removal methods are as follows:

1. Sand blasting with air or water;
2. High-pressure water;
3. Steam or super-heated water;
4. Mechanically grinding, sanding, scraping, brushing, burning.

Submit the method or methods to be used before use. The Contractor may submit written proposals for other removal methods. An approved method may be subsequently disapproved if it damages the pavement surface or inadequately removes existing markings.

Remove sand or other material on the pavement left by the removal as the work progresses.

Cover remaining discoloration with a thin asphalt fog coat.

Satisfactorily repair roadway surfaces damaged by marking removal at Contractor expense.

620.04 METHOD OF MEASUREMENT.

620.04.1 Preformed Plastic and Thermoplastic Pavement Markings. Preformed plastic and thermoplastic pavement striping is measured by the linear foot (meter).

Words and symbols are measured by the square foot (square meter).

620.04.2 Painted Pavement Markings and Curbs. Painted pavement striping, words and symbols, stop bars, crosswalks, hashmarks, and other stripping not placed by a stripping truck are measured by the gallon (Liter). Painting curbs is measured by the gallon (Liter).

Quantity measurements are based on flow meter/totalizer readings taken before and after each run or if a calibrated tank is used, tank measurements are taken before and after each run.

The amount of paint measured is the difference in the readings. All readings that measure paint for payment will be taken by the Project Manager. Provide all necessary assistance to make the readings including sufficient notice before the paint work begins.

620.04.3 Temporary Pavement Markings. Temporary pavement markings are measured under Subsection 618.04.2

620.04.4 Removal of Pavement Markings. Pavement stripping removal is measured by the linear foot (meter) based on a 4-inch (100 mm) width. Lines wider and narrower than 4-inches (100 mm) are converted to the equivalent linear feet (meter) of 4-inch (100 mm) wide line.

Removal of words and symbols is measured by the square foot (square meter) and converted to the equivalent linear feet (meter) of 4-inch (100 mm) wide line.

620.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Preformed Plastic/ Thermoplastic Pavement Striping	Linear Foot (meter)
Preformed Plastic/Thermo-plastic Markings Thermo-plastic Markings	Square Foot (Square Meter)
Truck-applied Painted Pavement Markings	Gallon (liter)
Words, symbols, Stop Bars, Hash Marks	Gallon (liter)
Painted Curb Markings	Gallon (liter)
Temporary Pavement Markings	Mile (kilometer)
Remove Pavement Markings	Linear Foot (Linear Meter) or Square Foot (Square Meter)

Repaint all highway striping represented by test samples showing volatiles exceeding 42 percent or when any paint property is outside 15 percent of any specified value at Contractor expense.

The contract unit price will be reduced by ten percent for traffic striping with any paint property outside 5 percent of any specified value.

Payment at the contract unit prices is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 621
REMOVE, RE-SET, AND ADJUST FACILITIES

621.01 DESCRIPTION. This work is removing, re-setting, or adjusting facilities and items as specified.

621.02 MATERIALS. Use the materials specified in the contact. Materials not specified and used in the work must be equal and comparable to those found in the existing work.

Obtain the Project Manager's approval before using material substitutions.

621.03 CONSTRUCTION REQUIREMENTS. Be responsible for the condition and care of each facility from the time removal starts until re-setting is completed.

Do not damage facilities when removing and re-setting.

Lower or raise existing manholes, catch basins, inlets, water valve boxes, gas and water shut-offs, and similar structures to grade as specified or directed. Make adjustments without damaging adjacent structures.

Construct masonry tops for manholes to the specified line and grade before placing the ring and cover.

Restore existing facilities to a structurally solid condition as specified.

Make height adjustments to water valve boxes without using an extension if possible.

Adjust manholes, catch basins, inlets, water valve boxes, and other similar structures to temporary grade before placing base course material. Make final adjustment of structures to match the grade of the new pavement. Replace and set to grade cast iron rings and covers once the pavement is placed.

Backfill around structures meeting Section 604 requirements.

Backfill holes left by removed facilities.

Reusable materials from removed structures or facilities may be used to rebuild the work. Stockpile all removed material not reused as specified. The material is the facility owner's property.

621.04 METHOD OF MEASUREMENT. Remove, re-set, and adjust facilities is measured by the unit.

621.05 BASIS OF PAYMENT. The item description for "Remove and Re-set" is abbreviated to "Re-set".

Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Re-set	Each

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 622
GEOSYNTHETICS CONSTRUCTION

622.01 DESCRIPTION. This work is furnishing and installing geosynthetic materials.

622.02 MATERIALS. Furnish materials meeting the following requirements:

Geotextiles & Geomembranes	Subsection 713.13
Drain Aggregate	Subsection 701.10
Geocomposites and Geogrids	As Specified

622.02.1 Classification. Geosynthetic materials include geotextiles, geomembranes, geocomposites, and geogrids, defined as follows:

A. **Geotextiles.** Any permeable textile used with foundation, soil, rock, earth, or any other geotechnical engineering-related material as an integral part of a project, structure, or system. Major functions include drainage, erosion control, separation and stabilization, sediment control, and pavement reinforcement.

B. **Geomembranes.** An essentially impermeable membrane used as a liquid or vapor barrier with foundation, soil, rock, earth, or any other geotechnical engineering-related material as an integral part of a project, structure, or system. Geomembranes are used in applications where a liquid or vapor barrier is required.

C. **Geocomposites.** A manufactured material using geotextiles, geogrids, geonets, and/or geomembranes in laminated or composite form. Major functions include separation, reinforcement, filtration, drainage, and moisture barriers.

D. **Geogrids.** A deformed or non-deformed grid-like polymeric material formed by intersecting ribs joined at the junctions used for reinforcement with foundation, soil, rock, earth, or any other geotechnical engineering-related material as an integral part of a project, structure, or system.

622.02.2 Sampling and Acceptance. Clearly label each roll of geosynthetic shipped to the project with the name and address of the manufacturer, type or grade, product name, quantity, month and year of manufacture, and lot number. Supply with each lot, 2 copies of a notarized manufacturer's certificate of compliance signed by an authorized manufacturer's official. The certificate must attest that the geosynthetic supplied meets all the requirements specified in Subsection 713.13. Submit the Certificates of Compliance to the Project Manager when the material arrives on the project.

Cut samples from the rolls delivered to the project, as directed and witnessed by the Project Manager. Cut at least a 1½ foot long (460 mm) strip the full length of the roll beyond the first wrap. Submit one sample every 10,000 square yards (8,360 m^2) per lot.

Install geosynthetics only after the material has been tested and accepted.

622.02.3 Shipment and Storage. Protect geosynthetics during shipment and storage from direct sunlight, ultraviolet rays, temperatures exceeding 140°F (60 °C), mud, dirt, dust, and debris following the manufacturers recommendations.

622.03 CONSTRUCTION REQUIREMENTS.

622.03.1 Installation Requirements.

A. General. Dispose of material with defects, rips, holes, flaws, deterioration, or other damage. Do not use defective material in the work.

Prepare the surface to receive the material by smoothing, removing objects harmful to the geosynthetic, leveling depressions, and removing debris and soft or low-density areas of surface material following the manufacturer's recommendations.

Place the geosynthetic without wrinkles and lap at least 2 feet (610 mm) at the ends and sides of adjoining sheets or as specified by the manufacturer, whichever is greater. Field sew lap if required.

Place stone, gravel, or other specified aggregate on the material without tearing, puncturing, or shifting. Repair or replace all torn or punctured material at Contractor expense. Make repairs following the manufacturer's recommendations or use a patch of the same material placed over the ruptured area, overlapped at least 3 feet (915 mm) from the edge of any part of the rupture. Sewing repairs are an acceptable alternate.

Follow the manufacturer's recommendations for securing the material in place on sloped surfaces and for riprap bedding installations.

Place the specified cover material on the geotextile within 5 working days of the geotextile installation.

B. Under Drains. Furnish and install geotextiles for under-drains that are specifically designed for this use and meet Subsection 713.13 requirements.

Construct under-drains as specified. Use drain aggregate specified in Subsection 701.10.

Place and compact the top 18-inches (460 mm) of the drain aggregate meeting the applicable requirements of Subsection 603.03.4 when installing under-drains under traffic lanes.

C. Erosion Control. Furnish and install geotextiles under riprap or gabions that are designed for this use and meet Subsection 713.13 requirements.

Place the geotextile with the long dimension parallel to the centerline of the channel. Make laps downstream and downslope.

Place riprap without puncturing, shifting, or damaging the geotextile. Fill all riprap face voids completely covering the geotextile.

Key the geotextile at least 18-inches (460 mm) into the ground at the top of the embankment. Finish the bottom (toe) by lapping the material back and secure with riprap, as specified.

D. Separation and Stabilization. Furnish and install geotextiles for separation and stabilization, designed for these applications that meet Subsection 713.13 requirements.

Do not operate vehicles and equipment directly on the geotextile when placing fill material.

Keep equipment wheels and tracks off of fabric laps when placing fill.

Place the first fill lift in a uniform layer, 15 to 20-inches (380 to 510 mm) loose thickness. Compact the top 8-inches (205 mm) using rubber-tired rollers. Do not use vibratory or sheepsfoot compaction equipment on the first lift. Do not operate haul units, crawler-type equipment, and other heavy equipment, excluding that used to place the fill, on the first lift until compacted. Use only rubber-tired rollers for compaction if any foundation failures occur when placing subsequent lifts. Compact all lifts to the moisture and density requirements for earth embankment specified in Subsection 203.03.3.

E. Sediment Control. Furnish and install geotextiles for sediment control (silt fences and brush barriers), designed for these applications and that meet Subsection 713.13 requirements.

Attach the material to the support system following the manufacturer's recommendations or as specified. Bury the bottom (toe) in a ground trench cut at least 6-inches (155 mm) deep. Backfill the geotextile bottom (toe) with soil if rock is encountered and a trench cannot be dug.

F. Paving. Furnish and install pavement geotextile as specified in the Contract.

G. Geomembranes. Furnish and install geomembranes as specified in the Contract.

H. Geocomposites and Geogrids. Furnish and install geocomposites and geogrids as specified in the Contract.

622.04 METHOD OF MEASUREMENT. Geosynthetics are measured by the square yard (square meter) as staked by the Project Manager. Measurement excludes laps, seams, and joints.

Aggregates are measured by the cubic yard (cubic meter) in place. If the Contract does not contain contract unit prices for the specified aggregate, the aggregate is not measured for payment.

622.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Geosynthetic	Square Yard (square meter)
Aggregate	Cubic Yard (cubic meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.

SECTION 701
AGGREGATES

701.01 AGGREGATE FOR CONCRETE. These specifications describe the quality and size of fine and coarse aggregate for portland cement concrete pavements and bases, highway bridges, and incidental structures.

The following test methods are used to evaluate the quality of aggregates for concrete:

Fineness Modulus of Fine Aggregate	AASHTO M 6
Sieve Analysis for Fine and Coarse Aggregate	MT-202
Wear Test	MT-209
Soundness	AASHTO T 104
Mortar-Making Properties	AASHTO T 71
Organic Impurities	AASHTO T 21
Coal and Light Particles	AASHTO T 113
Clay Lumps	AASHTO T 112
Petrographic Examination	*2-456-1

*Test method available from Materials Bureau

When wear factors are specified in the Contract, the term "aggregate surfacing" includes the coarse aggregate for concrete.

701.01.1 Fine Aggregates For Concrete.

A. General Requirements. Fine aggregate is natural sand having hard, strong, durable particles meeting the gradation requirements in Table 701-2.

Other approved inert material with similar characteristics or combinations of the above materials may be used, if the materials meet these specifications.

Do not mix or store in the same pile fine aggregate from different sources or use alternately in the same class of construction or mix without the Project Manager's written permission.

The deleterious substances and soundness specified in (B) and © below will be waived for aggregate used in structures or portions of structures not exposed to weather.

B. Deleterious Substances. Meet the deleterious material limits in Table 701-1.

TABLE 701-1
LIMITS ON DELETERIOUS MATERIAL
IN FINE AGGREGATE

MATERIAL	MAXIMUM % BY Wt
Coal and Lightweight Pieces	1.00
Clay Lumps	1.00

The material must not contain other deleterious material, such as shale, alkali, mica, coated grains, and soft, flaky particles.

C. Soundness. When fine aggregate is subjected to 5 cycles of the sodium or magnesium sulfate soundness test, the total corrected loss cannot exceed 10 and 15 percent by weight respectively.

D. Organic Impurities. Aggregate subjected to the colorimetric test for organic impurities and producing a color darker than the standard will be rejected unless the aggregates pass the mortar strength test specified in (E) below. Do not use aggregates showing a darker color than that of samples originally approved for the work until tested to determine whether the increased color indicates an harmful quantity of deleterious material.

E. Mortar-Making Properties. The fine aggregate, when mixed with Type I or II cement and tested using the mortar making property test, must develop at 7 days, a minimum compressive strength of 95% of the strength developed by a mortar made with the same cement under AASHTO T 71.

F. Grading. The gradation requirements in Table 701-2 are the outer acceptance limits for use from all supply sources. The gradation must be uniform from any one source and not change from the low to the high gradation limits.

The fineness modulus of samples taken from proposed sources must be a minimum 2.50 and a maximum 3.10 when tested under AASHTO M 6. Fine aggregate from a source with a fineness modulus variation greater than plus or minus 0.20 from the design fineness modulus of the sample may require a concrete mix redesign. Applying the 0.20 variation will not permit the fineness modulus to be less than 2.50 or more than 3.10.

TABLE 701-2
TABLE OF GRADATIONS - FINE AGGREGATE FOR CONCRETE

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES	
Sieve Size	**Percent Passing**
3/8" (9.5 mm)	100
No. 4 (4.75 mm)	95-100
No. 8 (2.36 mm)	80-100
No. 16 (1.18 mm)	50-85
No. 30 (0.600 mm)	25-60
No. 50 (0.300 mm)	5-30
No. 100 (0.150 mm)	0-10
No. 200 (0.075 mm)	0-3

A maximum 45% of the fine aggregate can be retained between any two consecutive sieves.

701.01.2 Coarse Aggregate For Concrete.

A. General Requirements. Coarse aggregate is crushed stone, gravel, or blast-furnace slag having hard, strong, durable pieces, free from adherent coatings. Other approved inert materials with similar characteristics or combinations of the above materials may be used, provided they meet these specifications.

The limits for deleterious material and soundness specified in (B) and © below will be waived for aggregate used in structures or portions of structures not exposed to the weather.

B. Deleterious Substances. Meet the deleterious material limits in Table 701-3.

TABLE 701-3
LIMITS ON DELETERIOUS SUBSTANCES
IN COARSE AGGREGATE

SUBSTANCE	MAXIMUM % BY Wt
Coal and Lignite	1.00
Clay Lumps	0.25
Soft Fragments	5.00
Thin or elongated pieces having a length greater than five times average thickness	15.00
Material passing the No. 200 sieve	* 1.00

*In crushed aggregates, if the material finer than the No. 200 sieve consists of fracture dust essentially free from clay or shale, the maximum limit may be increased to 1.5 percent.

The material must not contain other deleterious material, such as shale, alkali, mica, coated grains, and soft, flaky particles.

C. Soundness. When the coarse aggregate is subjected to 5 cycles of the sodium or magnesium sulfate soundness test, the total percentage loss cannot exceed 12 and 18 percent by weight respectively.

D. Percentage of Wear. Furnish coarse aggregate having a wear factor not exceeding 40 percent.

E. VACANT.

F. Grading. Furnish 1½-inch (37.5 mm) aggregate meeting the gradations in Table 701-4 for No. 4 (4.75 mm) to 1½-inch (37.5 mm), furnished in two separate sizes respectively meeting the gradations for No.4 (4.75 mm) to 3/4-inch (19 mm) and 3/4 to 1½-inch (19 mm to 37.5 mm) size material.

Furnish ¾-inch (19 mm) aggregate meeting the gradations for No 4 (4.75 mm) to 3/4-inch (19 mm) material.

Furnish coarse aggregate uniformly graded between the limits specified in Table 701-4.

The aperture shape used for coarse aggregate acceptance has no relation to the size and shape of the aperture or screen type used in producing the material.

TABLE 701-4
TABLE OF GRADATIONS - COARSE AGGREGATE FOR CONCRETE

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES DESIGNATED SIZES				
SIEVE	**(NO.1) No. 4 to**	**(NO. 2) No. 4 to**	**(No. 3) No. 4 to**	**(No. 4) No. 4 to**
SIZE	**1 ½" (37.5 mm)**	**3/4" (19 mm)**	**1 ½" (37.5 mm)**	**½" (12.5 mm)**
2" (50 mm)	100		100	
1½" (37.5 mm)	95-100		90-100	
1" (25 mm)		100	20-55	
¾" (19 mm)	35-70	90-100	0-15	100
½" (12.5 mm)				90-100
⅜" (9.5 mm)	10-30	20-55	0-5	40-70
No. 4 (4.75 mm)	0-5	0-10		0-15
No. 8 (2.36 mm)		0-5		0-5

Note: Nos. 1, 2, 3, and 4 correspond to AASHTO/ASTM designations 467, 67, 4, and 7 respectively

701.02 AGGREGATE FOR SURFACING.

701.02.1 General Requirements. The following test methods, as applicable, are used to evaluate the surfacing aggregate quality:

Sieve Analysis For Fine And Coarse Aggregate MT-202
Wear Test MT-209
Liquid Limit, Plastic Limit, Plasticity Index MT-208
Fracture MT-217
Volume Swell of Bituminous Mixtures MT-305
Cleanness Value MT-228
Petrographic Examination 2-456-3*

*Test method available from Materials Bureau

Furnish aggregate surfacing materials free of deleterious material except as permitted in Table 701-5.

Do not use scoria (fired clay commonly found in conjunction with burned coal in the lignite fields of the state) as aggregate to be bituminized. Sources of scoria are common but not limited to Daniels, Sheridan, Roosevelt, McCone, Dawson,

Prairie, Wibaux, Custer, Fallon, Rosebud, Treasure, Bighorn, Powder River, and Carter counties.

Meet Table 701-5 limits.

TABLE 701-5
LIMITS ON DELETERIOUS SUBSTANCES IN AGGREGATE SURFACING

Substance	Maximum % by Wt*
Clay Lumps, Shale, Coal	1.5 each
Soft Particles	3.5 each

* Determined by Test Method 2-456-3

No combination of shale, clay, coal, and soft particles can exceed 3.5 percent.

The aggregate must not contain wood and other plant material.

The portion of the aggregate retained on the No. 4 sieve is coarse aggregate, and that passing the No. 4 sieve is fine aggregate.

When wear factors are specified in the Contract, the term "aggregate surfacing" includes all aggregates specified in Subsections 701.02.4 through .9.

701.02.2 Select Surfacing. Furnish select surfacing, including added binder or blending material, meeting Table 701-6 gradation requirements.

TABLE 701-6
TABLE OF GRADATIONS - SELECTED SURFACING

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES						
SIEVE SIZE	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**	**Grade 6**
4"(100 mm)	100					
3"(75 mm)		100				
2½"(63 mm)			100			
2" (50 mm)				100		
1½"(37.5 mm)					100	
1" (25 mm)						100
No.200 (0.075)	15max	15max	15max	15max	15max	15max

The maximum liquid limit and plasticity index for the material passing the No. 40 sieve is 30 and 6 respectively.

701.02.3 Sand Surfacing. Furnish sand surfacing meeting Table 701-7 gradation requirements.

TABLE 701-7
TABLE OF GRADATIONS - SAND SURFACING

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES					
SIEVE SIZE	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
1½"(37.5 mm)	100				
1" (25.0 mm)		100			
¾" (19.0 mm)			100		
½" (12.5 mm)				100	
No.4 (4.75 mm)					100
No.10 (2.00 mm)	65 min	65 max	65 min	50 min	50 min
No.200 (0.075)	20 max	20 max	20 max	20 max	20 max

The liquid limit for the material passing the No. 40 sieve is 25 maximum, and the plasticity index cannot exceed 0.

701.02.4 Crushed Base Course Type "A". Furnish crushed base course type "A", including added binder or blending material, meeting Table 701-8 gradation requirements.

TABLE 701-8
TABLE OF GRADATIONS - CRUSHED BASE COURSE TYPE "A"

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES			
SIEVE SIZE	**Grade 2**	**Grade 5**	**Grade 6**
4" (100 mm)	100		
3" (75 mm)	95-100		
2" (50 mm)		100	
1½" (37.5 mm)	80-100	95-100	100
1" (25.0 mm)			95-100
¾" (19.0 mm)	65-90	65-100	
½" (12.5 mm)			45-80
No. 4 (4.75 mm)	25-60	25-60	25-60
No. 10 (2.00 mm)	20-50	20-55	25-55
No. 200 (0.75 mm)	12 max	12 max	12 max

Meet the following requirements for crushed base course Type "A":

1. The maximum liquid limit and plasticity index for the material passing the No. 40 sieve is 25 and 6 respectively.
2. Dust ratio limitations do not apply.
3. A wear factor not exceeding 50 percent at 500 revolutions.
4. Furnish binder meeting Subsection 301.02.2 requirements.
5. At least 25% by weight of the aggregate retained on the No. 4 sieve must have at least one mechanically-fractured face.

701.02.5 Crushed Base Course Type "B". Furnish crushed base course type "B", including added binder or blending material, meeting Table 701-9 gradation requirements.

TABLE 701-9
TABLE OF GRADATIONS - CRUSHED BASE COURSE TYPE "B"

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES			
SIEVE SIZE	**Grade 1**	**Grade 2**	**Grade 3**
2" (50 mm)	100		
1½" (37.5 mm)		100	
1" (25 mm)	50-80		100
No. 4 (4.75 mm)	20-50	25-55	30-60
No. 10 (2.00 mm)			20-50
No. 200 (0.075 mm)	8 max	8 max	8 max

Meet the following requirements for crushed base course type "B":

1. The liquid limit for the fine aggregate passing the No. 40 must not exceed 35, while the plasticity index cannot exceed 10.
2. Dust Ratio: The portion passing the No. 200 sieve must not exceed two-thirds of the portion passing the No. 40 sieve.
3. A wear factor not exceeding 50 percent at 500 revolutions.
4. Up to 5% by weight of material one grade larger than that being produced is allowed. For example, when producing 1½-inch (37.5 mm) material, up to 5% of the total weight of material produced may be 2-inch (50 mm) material.
5. Furnish binder meeting Subsection 301.02.2 requirements.
6. At least 20 percent by weight of the aggregate retained on the No. 4 sieve must have one mechanically fractured face.

701.02.6 Crushed Top Surfacing Type "A". Furnish crushed top surfacing type "A", including added binder or blending material, meeting Table 701-10 gradation requirements.

TABLE 701-10
TABLE OF GRADATIONS - CRUSHED TOP SURFACING TYPE "A"

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES					
SIEVE SIZE	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
1" (25 mm)	100				
¾" (19.0 mm)		100			
⅝" (16.0 mm)			100		
½" (12.5 mm)				100	
⅜" (9.5 mm)					100
No. 4 (4.75 mm)	40-70	40-70	40-70	40-70	50-80
No. 10 (2.00 mm)	25-55	25-55	25-55	25-60	35-70
No. 200 (0.075 mm)	2-10	2-10	2-10	2-10	2-10

Meet the following requirements for crushed top surfacing type "A", including added binder or blending material:

1. Dust Ratio: the portion passing the No. 200 sieve cannot exceed two-thirds of the portion passing the No. 40 sieve.
2. The maximum liquid limit and plasticity index for the material passing the No. 40 sieve is 25 and 6 respectively.
3. The composite aggregate shall not contain adherent films of clay and other matter that prevents thorough coating with bituminous material. Bituminous material shall remain adhered to the material upon contact with water.
4. When the aggregate is to be bituminized, both the material source and the composite aggregate shall have a volume swell not exceeding 10 percent and not show cracking or disintegration.
5. Do not remove intermediate sizes from the material during production, unless authorized in writing.
6. Have a wear factor not exceeding 50 percent at 500 revolutions.
7. At least 35 percent by weight of the aggregate retained on the No. 4 sieve must have at least one mechanically-fractured face.

701.02.7 Crushed Top Surfacing Type "B". Furnish crushed top surfacing type "B", including added binder or blending material, meeting Table 701-11 gradation requirements.

TABLE 701-11
TABLE OF GRADATIONS - CRUSHED TOP SURFACING TYPE "B"

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES			
SIEVE SIZE	**Grade 1**	**Grade 2**	**Grade 3**
1½"(37.5 mm)	100		
1" (25 mm)		100	
¾" (19.0 mm)			100
½" (12.5 mm)			
No. 4 (4.75 mm)	40-80	40-80	40-80
No. 10 (2.00 mm)	25-60	25-60	25-60
No. 200 (0.075)	5-20	5-20	5-20

Meet the following requirements for crushed top surfacing type "B", including added binder or blending material:

1. Dust Ratio: the portion passing the No. 200 sieve cannot exceed two-thirds of the portion passing the No. 40 sieve.
2. The maximum liquid limit and plasticity index for the material passing the No. 40 sieve must not exceed 35, while the plasticity index may vary from 3 to 10.
3. A wear factor not exceeding 50% at 500 revolutions.
4. At least 20 percent by weight of the aggregate retained on the No.4 sieve must have one fractured face.

701.02.8 Crushed Cover Aggregate - Cover Material. Furnish cover material meeting the gradation requirements of Table 701-12.

TABLE 701-12
TABLE OF GRADATIONS - COVER MATERIAL

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES					
SIEVE SIZE	**Grade 1A**	**Grade 2A**	**Grade 3A**	**Grade 4A**	**Grade 5A**
⅝" (16.0 mm)	100				
½" (12.5 mm)		100	100		
⅜" (9.5 mm)	33-55	40-90	95-100	100	100
No. 4 (4.75 mm)	0-15	0-15	0-30	0-30	9-50
No. 8 (2.36 mm)	0-5	0-5	0-15	0-15	2-20
No. 200 (0.075 mm)	0-2	0-2	0-2	0-2	2-5

Meet the following requirements:

1. The material for Grades 1A through 4A must be non-plastic. For Grade 5A the liquid limit and plasticity index for the material passing the No. 40 sieve cannot exceed 25 and 6 respectively.
2. The composite aggregate must not have adherent films of clay, vegetable matter, frozen lumps, and other extraneous matter that prevents thorough coating with bituminous material. Bituminous material must remain adhered to the material upon contact with water. No combination of shale, clay, coal, and soft particles can exceed 1.5 percent.
3. A wear factor not exceeding 30 percent at 500 revolutions.
4. A minimum of 70 percent by weight of the coarse aggregate for Grades 1A through 4A must have at least one fractured face. A minimum of 50% by weight of the coarse aggregate for Grade 5A must have at least one fractured face.

701.02.9 Aggregate for Portland Cement Treated Base. Furnish aggregate for portland cement treated base, including added blending material, meeting Table 701-13 gradation requirements.

TABLE 701-13
TABLE OF GRADATIONS - AGGREGATE FOR CEMENT-TREATED BASE

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES	
SIEVE SIZE	**JOB MIX TARGET LIMITS**
¾" (19.0 mm)	100
No. 4 (4.75 mm)	40-70
No. 10 (2.00 mm)	25-55
No. 200 (0.075)	4-12

Meet the following requirements:

1. The maximum liquid limit and plasticity index for the material passing the No. 40 sieve must be 30 and 7 respectively.
2. The material used to produce the aggregate must have a wear factor not exceeding 50% at 500 revolutions.

701.03 AGGREGATE FOR BITUMINOUS MIXTURES.

701.03.1 General Requirements. The following test methods will be used to evaluate the quality of aggregate to be bituminized:

Sieve Analysis For Fine And Coarse Aggregate MT-202
Wear Test MT-209
Liquid Limit, Plastic Limit, Plasticity Index MT-208
Fracture MT-217
Volume Swell Of Bituminous Mixtures MT-305
Plastic Fines In Graded Aggregates MT-213
Petrographic Examination *2-456-2

*Test method available from materials Bureau

Aggregate for use in bituminous mixtures must not contain deleterious matter exceeding the percentages by weight determined by Test Method 2-456-2.

Do not use scoria (fired clay commonly found in conjunction with burned coal in the lignite fields of the state) as aggregate to be bituminized. Sources of scoria are common but not limited to Daniels, Sheridan, Roosevelt, McCone, Dawson, Prairie, Wibaux, Custer, Fallon, Rosebud, Treasure, Bighorn, Powder River, and Carter counties.

Meet the deleterious substances limits specified Table 701-14.

TABLE 701-14
LIMITS ON DELETERIOUS SUBSTANCES
IN AGGREGATE FOR BITUMINOUS MIXTURES

SUBSTANCE	MAXIMUM % BY Wt*
Clay Lumps, Shale, and Coal	1.5 each
Soft Particles	3.5 each

* Determined by Test Method 2-456-2

No combination of shale, clay, and soft particles can exceed 3.5 percent.

The portion of the aggregate retained on the No. 4 sieve is defined as coarse aggregate, and that passing the No. 4 sieve is defined as fine aggregate.

When wear factors are specified, the term "aggregate surfacing" includes all aggregates specified in Subsections 701.03.4 and .9.

701.03.2 Aggregate for Plant Mix Surfacing. Furnish aggregate for plant mix surfacing, including mineral filler when required, meeting Table 701-15 gradation requirements.

TABLE 701-15
TABLE OF GRADATIONS - AGGREGATE FOR PLANT MIX SURFACING

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES				
	GRADE A		GRADE B	
SIEVE SIZE	Job Mix Target Limits	Job Mix Tolerance	Job Mix Target Limits	Job Mix Tolerance
¾" (19.0)	100		100	
½" (12.5)	87-93	±8	86-90	±7
⅜" (9.5)	77-83	±8	75-79	±7
No. 4 (4.75)	52-58	±7	53-57	±7
No. 10 (2.00)	36-41	±6	34-40	±6
No. 40 (0.425)	19-21	±5	16-18	±5
No. 200 (0.075)	6-8	±2	5-7	±1

Meet the following requirements:

1. A wear factor not exceeding 40% at 500 revolutions using Montana Test MT-209.
2. For Grade A aggregate at least 50% by weight of the coarse aggregate particles must have at least one mechanically-fractured face. For Grade B aggregate at least 70% by weight of the aggregate must have at least one mechanically-fractured face.
3. The maximum liquid limit for the aggregate passing the No. 40 sieve is 25. The maximum plasticity index for Grade A aggregate is 6. Grade B aggregate must be non-plastic.
4. The final produced aggregate, including treated aggregate, must have a volume swell not exceeding 10% and cannot show cracking or disintegration.
5. The aggregate must not contain adherent films of clay and other matter that prevents thorough coating with bituminous material.

701.03.3 Aggregate for Open-Graded Friction Course. Furnish aggregate for open-graded friction course consisting of clean, hard, durable fragments of crushed stone or crushed gravel, plus filler fragments of finely crushed gravel, crushed stone, or sand meeting Table 701-16 gradation requirements.

TABLE 701-16
TABLE OF GRADATIONS - AGGREGATE FOR OPEN-GRADED FRICTION COURSE

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES	
SIEVE SIZE	**PERCENT PASSING**
⅜" (9.5 mm)	100
No.4 (4.75 mm)	30-50
No.8 (2.36 mm)	5-18
No.200 (0.075 mm)	2-5

Meet the following requirements:

1. At least 95% of the aggregate retained on the No. 4 sieve must have at least one mechanically-fractured face.
2. The liquid limit for the material passing the No. 40 sieve cannot exceed 25, and the plasticity index not exceed 0.
3. A wear factor not exceeding 30 percent.
4. The aggregate must not contain deleterious material that prevents thorough coating with bituminous material.

701.04 FOUNDATION AND BEDDING MATERIAL FOR STRUCTURES.

701.04.1 Bedding Material. Furnish bedding material for minor drainage structures and culvert foundations.

Furnish bedding material that is reasonably free of clay, silt, and other deleterious material and meets Table 701-17 gradation requirements.

TABLE 701-17
TABLE OF GRADATIONS - BEDDING MATERIAL

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES	
SIEVE SIZE	**PERCENT PASSING**
4" (100 mm)	100
No.4 (4.75 mm)	25-60
No.200 (0.075 mm)	12 max

Note: Use minus 1½-inch (37.5 mm) aggregate in the top 3-inches (75 mm) of bedding material.

701.04.2 Foundation Material. Foundation material is one or more aggregate material courses to provide a stable foundation for culvert and drainage structure installations in unstable areas.

Use shot rock, pit-run aggregate, crushed aggregate, or any combination of these materials. The largest rock or rock fragment allowed may be as great in dimension as the thickness of the lift being placed. In the top 1 foot (305 mm) of the foundation, the largest rock or rock fragment cannot exceed 8-inches (200 mm). Use well-graded material in the top 1 foot (305 mm) of foundation material. A maximum 40 percent by weight of the foundation material must pass a No. 4 sieve.

701.05 FILTER MATERIAL. Furnish filter material meeting Table 701-18 gradation requirements.

TABLE 701-18
TABLE OF GRADATIONS - FILTER MATERIAL

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES		
Sieve Size	**Gradation No. 1**	**Gradation No. 2**
2" (50 mm)		100
1½" (37.5 mm)		95-100
¾" (19.0 mm)		35-70
⅜" (9.5 mm)	100	10-30
No. 4 (4.75 mm)	95-100	0-5
No. 8 (2.36 mm)	80-100	
No. 16 (1.18 mm)	50-85	
No. 30 (0.60 mm)	25-60	
No. 50 (0.30 mm)	5-30	
No. 100 (0.15 mm)	0-10	

701.06 RIPRAP. Furnish stone that is hard, durable, angular in shape, resistant to weathering and water action, free from overburden, spoil, shale, structural defects, and organic material.

Each stone must have its greatest dimension not greater than 3 times its least dimension.

Do not use rounded stone or boulders from a streambed source as riprap. Do not use shale or stone with shale seams.

The stone will be accepted by the Project Manager based on visual analysis, the Department's Riprap evaluation form, or both. Submit samples at least 30 days before placing the riprap.

701.06.1 Handlaid Riprap. Furnish stone or rock fragment at least 3-inches (75 mm) thick, a minimum ½ cubic foot (0.014 m^3) in volume, weighing at least 75 pounds (34 kg), excluding rock spalls.

Extend all stones and fragments through the revetment, except spalls used to chock larger stones and fill voids between the larger stones.

701.06.2 Random Riprap. Furnish the specified random riprap meeting Table 701-19 requirements.

TABLE 701-19
TABLE OF GRADATIONS - RANDOM RIPRAP

Class	Weight of Stone	Equivalent Spherical Diameter*	Percent of Total Weight That Must Be Smaller Than Given Size
I	100 lb (45 kg) 60 lb (27 kg) 25 lb (11 kg) 2 lb (0.90 kg)	1.05 ft (320 mm) 0.88 ft (270 mm) 0.66 ft (200 mm) 0.27 ft (80 mm)	100 70 - 90 40 - 60 0 - 10
II	700 lb (318 kg) 500 lb (227 kg) 200 lb (91 kg) 20 lb (9.0 kg)	2.00 ft (610 mm) 1.79 ft (545 mm) 1.32 ft (400 mm) 0.61 ft (190 mm)	100 70 - 90 40 - 60 0 - 10
III	2000 lb (09 kg) 1400 lb (35 kg) 700 lb (318 kg) 40 lb (18 kg)	2.82 ft (860 mm) 2.53 ft (770 mm) 2.00 ft (610 mm) 0.77 ft (235 mm)	100 70 - 90 40 - 60 0 - 10

*Based on unit weight of 165 lb/ft^3 (2 675 kg/m^3)

701.06.3 Grouted Riprap. Furnish stone for grouted riprap meeting Subsection 701.06.2 requirements.

701.07 BANK PROTECTION. Furnish rock that is hard, dense, and durable. Use either quarried rock or natural coarse gravel. Rock may be obtained from adjacent roadway excavation. Do not use rock obtained from streambeds.

Furnish the specified bank protection meeting Table 701-20 requirements.

TABLE 701-20
SIZE REQUIREMENTS - BANK PROTECTION

TYPE	1	2	3	4
Nominal Thickness	24" (610 mm)	18" (460 mm)	12" (305 mm)	Coarse Gravel
Overall Thickness Including Bedding	30" (760 mm)	24" (610 mm)	18" (460 mm)	As Specified in the Contract
Largest rock Permissible	1/4 Cu Yd (0.19 m^3)	1/8 Cu Yd (0.09 m^3)	1 Cu Ft (0.03 m^3)	1/8 Cu Ft (0.003 m^3)
Smallest rock Permissible	1/10 Cu Ft (0.003 m^3)	1/10 Cu Ft (0.003 m^3)	1-1/2" (40 mm)	3/16" (5 mm)

701.08 SAND-GRAVEL CUSHION. Furnish sand-gravel cushion for concrete slope protection meeting Subsection 701.04.1 requirements for bedding material except that all the material must pass a 1½-inch (38 mm) sieve.

701.09 BACKFILL FOR METAL BIN-TYPE RETAINING WALLS. Furnish backfill for the bins specified by the bin manufacturer. If not specified, use a gravel-type soil with 95 percent passing the 2-inch (50 mm) sieve and not more than 10 percent passing the No. 200 sieve. The material volume swell cannot exceed 10 percent and must have a plasticity index not exceeding 10.

701.10 DRAIN AGGREGATE. Furnish drain aggregate that is rounded to sub-rounded aggregate meeting Table 701-21 gradation requirements.

TABLE 701-21
TABLE OF GRADATIONS - DRAIN AGGREGATE

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES	
Sieve Size	**Percent Passing**
6" (152 mm)	100
¾" (19 mm)	0-10
No.4 (4.75 mm)	0-5

SECTION 702
BITUMINOUS MATERIALS

702.01 BITUMINOUS MATERIALS. Furnish bituminous materials meeting the requirements of the following tables. The MDT tables are located at the end of this section.

(1) Asphalt Cement 702-3
(2) Rapid Curing Liquid Asphalt(RC) 702-4
(3) Medium Curing Liquid Asphalt(MC) 702-5
(4) Slow Curing Liquid Asphalt(SC) 702-6
(5) High Float Emulsions 702-7
(6) Emulsified Asphalt ..... AASHTO M 140, Table 1
AASHTO M 208, Table 1

Meet the requirements for bituminous materials specified in the Contract.

702.02 TESTING AND ACCEPTANCE.

A. **All Properties Except Asphalt Cement Penetration.** Bituminous materials are accepted on the test results of samples selected and tested by the Department or its authorized representative. Collect samples as specified in Subsection 402.03.2 and tested using the applicable AASHTO method. The Project Manager may permit using bituminous materials before the test results are available, if the test results of material previously furnished by the refiner have consistently been satisfactory. Bituminous materials used before receipt of the test results and permitted by the Project Manager does not waive the Department's right to accept or reject materials under these specifications.

B. **Asphalt Cement Penetration.** Asphalt cement penetration is sampled and accepted under Subsections 402.03.2 and 402.03.5(B).

TABLE 702-1

BASIS FOR ACCEPTANCE OF BITUMINOUS MATERIALS					
SAMPLE TESTED	SPECIFICATION LIMITS[1]		TOLERANCE LIMITS[2]		REMARKS
	Test Results Within Limits	Test Results Outside Limits	Test Results Within Limits	Test Results[3] Outside Limits	
Original Sample	Accept Material	Apply Tolerance Limits[2]	Accept Material	Test Retained Sample	Retained sample will be tested only if test results of original sample are outside tolerance limits.
Retained Sample	Accept Material	Apply Tolerance Limits[2]	Accept Material	Accept Material at Reduced Price or Reject	

[1] - See specification for bituminous materials.

[2] - Tolerance limits are applied to the minimum and maximum specification values of specification tables. See Table 702-2 for Schedule of Tolerances.

[3] - Do not retain a second sample for bituminous sample accepted under Q.A. Pay adjustments will be applied under Q.A.

If test results of both the original and retained samples are not within the tolerance limits, the average of the two values will determine the basis for acceptance of the material.

Exception: If either of the two test values are outside the applicable ASTM Repeatability Range, then the test value numerically nearest the specification requirement will be used as the basis for acceptance. In the event a material fails more than one test requirement, that requirement with the greatest violation will determine the basis for acceptance. See Subsection 402.03.5© for the method of calculating price reductions.

TABLE 702-2
SCHEDULE OF TOLERANCES

ALLOWABLE VARIATION			
TEST	**From Min. Specification Requirement**	**From Max. Specification Requirement**	**REMARKS**
Flash Test Asphalt Cement Cutback Asphalt	 -5% -10%		
Penetration Liquid Asphalt Distillation Residues	-10%	+10%	
% Residue from Distillation	5%		% of Total Distillate: 2 ml may be added or subtracted at any distillation temp. before calculating the % recovered
Ductility	-10%		
Solubility	-0.5%		
Viscosity Cutback Asphalts Emulsified Asphalts	 -10% 0%	 +10% +25%	Emulsified asphalt in violation of the minimum specification requirement subject to rejection and removal from the work or 50% price reduction at the Engineer's discretion.
% Residue of 100 Pen.	-5%		
Thin Film Oven Test % loss in wt. % retained Pen.	 -2%	 +10%	
Demulsibility and Sieve Tests	-10%	+10%	
Spot Test	NO TOLERANCE - Materials in violation of spec. subject to standard price reduction.		
Water	NO TOLERANCE - Materials in violation of spec. subject to rejection or 50% price reduction at the Engineer's discretion.		
Particle Charge	NO TOLERANCE - Materials in violation of spec. and any aggregate used in conjunction with its use will, at the Engineer's discretion, be either rejected or paid for at a unit rate not to exceed 50% of the cost of the materials.		

TABLE 702-3
SPECIFICATION FOR ASPHALT CEMENT

	Penetration Grade 40-50		60-70		85-100		120-150		200-300	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Penetration at 25°C (77°F) 100 g. 5 sec.	40	50	60	70	85	100	120	150	200	300
Flash point, Cleveland Open Cup	450	—	450	—	450	—	425	—	350	—
Ductility at 25°C (77°F) 5 cm. per min., cm	100	—	100	—	100	—	100	—	—	—
Solubility	99	—	99	—	99	—	99	—	99	—
Thin-film oven test, ⅛ in. (3.2 mm), 163°C (325°F) 5 hour loss on heating, percent	—	0.8	—	0.8	—	1.0	—	1.3	—	1.5
Penetration of residue percent of original	58	—	54	—	50	—	46	—	40	—
Ductility of residue at 25°C (77°F) 5 cm. per min., cm.	—	—	50	—	75	—	100	—	100	—
Spot test	Negative for all grades									

TABLE 702-4
SPECIFICATIONS FOR RAPID CURING LIQUID ASPHALTS

	RC-70		RC-250		RC-800		RC-3000	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Kinematic Viscosity at 60°C (140°F) (See Note 1) centistokes	70	140	250	500	800	1600	3000	6000
Flash point (Tag, open-cup), degrees C (F)	—	—	27 (80)	—	27 (80)	—	27 (80)	—
Water, percent	—	0.2	—	0.2	—	0.2	—	0.2
Distillation test: Distillate, percentage by volume of total distillate to 360°C (680°F)								
to 190°C (374°F)	10	—	—	—	—	—	—	—
to 225°C (437°F)	50	—	35	—	15	—	—	—
to 260°C (500°F)	70	—	60	—	45	—	25	—
to 315°C (600°F)	85	—	80	—	75	—	70	—
Residue from distillation to 360°C (680°F) volume percentage of sample by difference	55	—	65	—	75	—	80	—
Tests on residue from distillation:								
Penetration, 100 g., 5 sec. at 25°C (77°F)	80	120	80	120	80	120	80	120
Ductility, 5 cm./min. at 25°C (77°F) cm.	100	—	100	—	100	—	100	—
Solubility	99	—	99	—	99	—	99	—

Note 1. As an alternate, Saybolt-Furol viscosities may be specified as follows:
Grade RC-70 - Furol viscosity at 50°C (122°F) - 60 to 120 sec.
Grade RC-250 - Furol viscosity at 60°C (140°F) - 125 to 250 sec.
Grade RC-800 - Furol viscosity at 82.2°C (180°F) - 100 to 200 sec.
Grade RC-3000 - Furol viscosity at 82.2°C (180°F) - 300 to 600 sec.

TABLE 702-5
SPECIFICATION FOR MEDIUM CURING LIQUID ASPHALTS

	MC-30		MC-70		MC-250		MC-800		MC-3000	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Kinematic Viscosity at 60°C (140°F) (See Note 1) centistokes	30	60	70	140	250	500	800	1600	3000	6000
Flash point (Tag, open-cup), degrees C (F)	38 (100)	—	38 (100)	—	66 (150)	—	66 (150)	—	66 (150)	—
Water, percent	—	0.2	—	0.2	—	0.2	—	0.2	—	0.2
Distillation test: Distillate, percentage by volume of total distillate to 360°C (680°F)	—	25	0	20	0	10	—	—	—	—
to 225°C (437°F)	40	70	20	60	15	55	0	35	0	15
to 260°C (500°F)	75	93	65	90	60	87	45	80	15	75
to 315°C (600°F)										
Residue from distillation to 360°C (680°F) Volume percentage of sample by difference	50	—	55	—	67	—	75	—	80	—
Tests on residue from distillation:										
Penetration, 100 g. 5 sec. at 25°C (77°F)	120	250	120	250	120	250	120	250	120	250
Ductility, 5 cm/cm., cm. (See Note 2)	100	—	100	—	100	—	100	—	100	—
Solubility	99	—	99	—	99	—	99	—	99	—
Spot test	Negative for MC-3000 only									

Note 1. As an alternate, Saybolt-Furol viscosities may be specified as follows:
Grade MC-70 - Furol viscosity at 50°C (122°F) - 60 to 120 sec.
Grade MC-30 - Furol viscosity at 25°C (77°F) - 75 to 150 sec.
Grade MC-250 - Furol viscosity at 60°C (140°F) - 125 to 250 sec.
Grade MC-800 - Furol viscosity at 82.2°C (180°F) - 100 to 200 sec.
Grade MC-3000 - Furol viscosity at 82.2°C (180°F) - 300 to 600 sec.

Note 2. If the ductility at 25°C (77°F) is less than 100, the material will be acceptable if its ductility at 15.5°C (60°F) is more than 100.

TABLE 702-6
SPECIFICATIONS FOR SLOW CURING LIQUID ASPHALTS

	SC-70		SC-250		SC-800		SC-3000	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Kinematic Viscosity at 60°C (140°F) (See Note 1) Centistokes	70	140	250	500	800	1600	3000	6000
Flash point (Cleveland, open-cup), degrees C (F)	66 (150)	— —	79 (175)	— —	93 (200)	— —	107 (225)	— —
Water, percent	—	0.5	—	0.5	—	0.5	—	0.5
Asphalt residue of 100 pen., percent by wt.	50	—	60	—	70	—	80	—
Distillation test: Total distillate to 360°C (680°F), percent by volume	10	30	4	20	2	12	—	5
Tests on residue from distillation: Kinematic Viscosity at 60°C (140°F), Centistokes	4	70	8	100	20	160	40	350
Ductility of 100 pen., residue at 25°C (77°F), 5 cm. per min., cm.	100	—	100	—	100	—	100	—
Solubility	99	—	99	—	99	—	99	—

Note 1. As an alternate, Saybolt-Furol viscosities may be specified as follows:
Grade SC-70 - Furol viscosity at 50°C (122°F) - 60 to 120 sec.
Grade SC-250 - Furol viscosity at 60°C (140°F) - 125 to 250 sec.
Grade SC-800 - Furol viscosity at 82.2°C (180°F) - 100 to 200 sec.
Grade SC-3000 - Furol viscosity at 82.2°C (180°F) - 300 to 600 sec.

TABLE 702-7
SPECIFICATIONS FOR HIGH FLOAT EMULSIONS

GRADE	HF-100		
	Min.		Max.
Tests on emulsions:			
Viscosity Saybolt Furol at 122°F (50°C) sec.	50		400
Storage stability 24 hr., %	—		1
Sieve test, %	—		0.1
Demulsibility, 50 ml. 5.55 g/L $CaCl_2$, % by mass	30		—
Distillation:			
Residue, %	65		—
Oil distillate, by volume of emulsion, %	—		2
Tests on residue from distillation test:			
Penetration 25°C (77°F), 100 g. 5 sec.	100		170
Ductility 25°C (77°F) 5 cm per min., cm	40		—
Solubility	95.5		
Float Test 140°F, sec.	1200		—

SECTION 703
LIGHTING & SIGNAL MATERIALS

703.01 GENERAL. Furnish all electrical equipment meeting the requirements of the National Electrical Manufacturers Association (NEMA) or the Radio Manufacturers Association (RMA), whichever is applicable. Meet the Contract requirements, the National Electrical Code (referred to as the Code); the standards of the American Society for Testing Materials (ASTM); the American National Standards Institute (ANSI); and all state and local laws or ordinances that may apply.

References to the above codes or standards are the current editions of the code, order, or standard at the time the contract is let and governs throughout the life of the contract.

Furnish galvanized parts and meeting ASTM A 153, B 454 (Class 50), or other applicable ASTM galvanizing specifications. Anchor bolts may be galvanized, or cadmium plated with type NS coating meeting ASTM A 165. Galvanized bolts and nuts must thread together without damaging the coating.

703.02 CONDUIT

703.02.1 Plastic Conduit. Furnish rigid polyvinyl chloride meeting UL 651, schedule 40 and 80, 150 °F (66 °C) wire rated, direct bury type. Install conduit meeting the applicable requirements of Section 616.

703.02.2 Steel Conduit. Furnish galvanized rigid steel conduit and fittings of mild steel meeting UL 6 and ANSI C 80.1 requirements.

Cut a 12-inch (305 mm) sample, witnessed by the Project Manager, from the end of each conduit size for testing. Tests will be by ASTM A 239.

Install conduit meeting the applicable requirements of Section 616.

703.03 PULL BOXES.

703.03.1 Concrete Pull Boxes. Furnish concrete pull boxes, extensions, and covers made of reinforced concrete. Use class "DD" concrete meeting Section 551 requirements. Use reinforcing steel meeting Section 555 requirements.

Meet the pull box size and details specified in the Contract.

Inscribe reinforced concrete covers for signal systems, or combined signal and low-voltage lighting systems with the words "TRAFFIC SIGNALS". Furnish reinforced concrete covers for lighting systems inscribed with the words "STREET LIGHTING" ("HIGH VOLTAGE" where specified). Provide two ⅜-inch (9.5 mm) brass or stainless steel hold-down bolts, washers and nuts with the cover. Recess the nuts below the surface of the cover. Furnish a steel cover designed to withstand AASHTO H-20 loads for pull boxes subject to traffic loads.

Assure pull boxes are watertight. Seal the covers with a ¼-inch (6 mm) bead of asphaltic mastic in the cover recess. Make conduit enter from the bottom of the box.

Furnish metal frames and covers for boxes or vaults formed in the concrete. Inscribe covers with the wording specified in the Contract. Assure gasket surfaces form a true plane. Install a ⅛-inch (3 mm) one piece neoprene gasket on the frame or cover for the seal.

703.03.2 Metal Pull Boxes. Furnish metal pull boxes made from cast iron with a checkered steel cover, both hot dip galvanized. Attach the cover to the box with brass or stainless steel screws. Provide the cover with a gasket that, with the cover in place, forms a NEMA Type 4 watertight fit. Boss, drill, tap and treat conduit entrances to the box for corrosion protection. Meet the pull box size and details shown in the Contract.

703.03.3 VACANT.

703.04 STANDARDS AND POSTS.

703.04.1 General. Furnish standards fabricated under Section 556 and designed meeting the AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals".

Use a minimum luminaire dead load of 75 pounds (34 kg), and a minimum luminaire projected area of 3.3 square feet (0.31 m^2) for design purposes. Use a design wind velocity for all standards of 90 miles per hour (145 km/hr).

All standards must be steel. Once the standards, posts, or pedestals are erected and the installation complete, grout any gap between the base and foundation using grout meeting Subsection 713.05 requirements. Form a ¾-inch (19 mm) drain hole in the grout at the lowest point.

Install standards or posts as specified in the Contract.

703.04.2 Type 2 and 3 Signal Standards. Furnish a single steel section shaft formed into a round, continuous taper with a single, automatic electrically welded seam, or an approved equal.

Show the type of steel used for the shafts on the shop drawings.

Provide four high-strength steel anchor bolts with each shaft. Furnish each anchor bolt with two nuts and two washers over and under the shaft base to adjust rake and plumb.

Field drill other holes for wire entry, mounting pedestrian and vehicle signals, or pedestrian push buttons. Treat the holes or threads with a cold galvanizing compound following the manufacturer's directions.

All accessories welded to the shaft must be factory-welded before galvanizing.

Furnish raintight metal covers for the top of Type 2A and 3A signal standards.

703.04.3 Type 10 Luminaire Standards. Shafts must be a single section formed into a round, continuous taper with a single, automatic electrically-welded seam, or approved equal. Steel shafts must be a minimum No.11 Manufacturer's Standard Gauge.

Show the type of steel on the manufacturer's shop drawings.

Provide a rain-tight cover for the top of each shaft.

Shafts **not mounted** on transformer bases must have a handhole with removable cover and an internal grounding lug, as shown on the plans. Locate the handhole in the same quadrant as the mast arm.

Shafts **mounted** on transformer bases do not require a handhole or grounding lug.

The shaft base (anchor or breakaway) to be used is specified in the Contract.

The shaft base plate must be a one-piece plate circumferentially welded to the shaft for anchor and breakaway base types.

For anchor bases, the base plate must attach directly to the anchor bolts. Furnish each anchor bolt with two nuts and two washers for plumbing and raking the shaft.

For breakaway bases, the plate must be attached to a breakaway device that attaches to the anchor bolts.

Use breakaway bolt couplings unless they will not function with the approved luminaire standard. The bolt coupling must meet AASHTO publication," Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals" requirements.

Use frangible transformer bases where bolt couplings cannot be used. Transformer bases must have an access door, grounding lug, and factory-made shims for plumbing. Provide each anchor bolt with one nut and one washer.

Provide four high strength steel anchor bolts with each shaft. Furnish "L" shaped anchor bolts with a minimum 6-inches (155 mm) of the bolt threaded at the top. Size the anchor bolt following the shaft manufacturers recommendations.

Anchor bolts used with breakaway bolt couplings must project out of the foundation the length recommended by the coupling manufacturer. Furnish the breakaway bolt coupling, washer, nut and bolt covering that enclose the area between the baseplate and foundation.

Anchor bolts used with transformer bases must project at least 3-inches (75 mm) from the foundation.

Provide a mounting base where the mast arm connects to the shaft. Provide an opening in the base for running wire from the shaft to the mast arm.

Field drill other holes for wire entry, mounting pedestrian and vehicle signals, or pedestrian push buttons. Treat the holes or threads with a cold galvanizing compound following the manufacturers recommendations.

All accessories welded to the shaft must be factory-welded before galvanizing.

703.04.4 Mast Arms - Signal and Luminaire. Mast arms must be single tapered members.

The mast arm end must have a 2-inch (50 mm) slip-fitter tenon at least 6-inches (155 mm) long.

All accessories welded to the mast arm must be factory-welded before galvanizing.

Mast arm lengths and mounting heights are shown on the plans.

703.04.5 Type 1-80, 1-100, 1-120, 1-140, and 1-160 Signal Standards. Furnish standards as specified in the Contract.

Furnish a cast aluminum base with an internal ground lug and handhole with removable cover. Plumb bases with factory-made shims. Provide a nut and washer with each anchor bolt for the base.

Anchor bases may be used when a single conduit enters the shaft base. The anchor base must be a one-piece steel plate circumferentially welded to the shaft before galvanizing. Furnish two nuts and two washers with each anchor bolt for plumbing and raking the standard.

Provide four high strength steel anchor bolts with each shaft. Furnish "L" shaped anchor bolts with a minimum 6-inches (155 mm) of the bolt threaded at the top.

Leave anchor bolts projecting at least 3-inches (75 mm) from the foundation.

Follow the manufacturer's recommendations for anchor bolt size and bolt circle.

Field drill holes for wire entry, mounting pedestrian and vehicle signals, or pedestrian push buttons. Treat the holes or threads with a cold galvanizing compound following the manufacturer's recommendations.

All accessories welded to the shaft must be factory-welded to the shaft before galvanizing.

703.04.6 Welding Steel. Meet the American Welding Society Specifications for Welded Highway and Railway Bridges, AWS D-1.1-75 and AWS D1.1 or current revisions, and as amended by AASHTO and the Montana Supplemental Specifications for Welding (blue sheets found in the contract).

Furnish weld procedures with the shop drawings showing complete welded joint details including material, process, procedure, filler metal, welding technique, workmanship, dimensional tolerances for each type joint used in fabrication, pre-heat, interpass, and heat treatment temperature schedules.

703.04.7 VACANT.

703.04.8 Finish. Furnish standards galvanized inside and out. A primer finish is not acceptable. Use stainless steel or zinc, cadmium, or galvanized coated fasteners. Provide galvanized nuts, washers, and shims for anchor bolts.

703.04.9 Wire Protection. Use insulated bushings or grommets to prevent wire abrasion at all wire openings and inlets.

703.04.10 Inspection. All standards will be inspected at the project before they are erected and may be inspected where fabricated.

703.05 CONCRETE FOUNDATIONS. Use Class "D" concrete for all foundations for standards.

Concrete quantity increases for foundations to accommodate the standard furnished by the manufacturer are at Contractor expense.

Construct foundations to accommodate the steel conduit and anchor bolts as specified.

Pancake grounds cannot be used.

Reinforce foundations with No.4 (#10M) hoops at 1-0' (610 mm) centers and with eight No.6 (#20M) bars equally spaced around the hoops. Form the top 6-inches (155 mm) of the foundation, beveling the exposed concrete edge 2-inches (50 mm). Electrically bond all conduit in each foundation to an anchor bolt using a AWG No.6 copper grounding strap. Connect a bare copper AWG No.6 solid wire between the grounding lug on the standard and the grounding strap.

703.06 CONDUCTORS AND CABLE.

703.06.1 Conductors. Furnish conductors of solid or stranded copper of the gauge shown in the Contract.

Insulation for conductors must be Type THW, XHHW, USE, RHH, RHW, THWN, or THHN.

All insulation must be designed for 600 volts and meet the code requirements.

Supply connectors and fuses shown in the Contract and required to complete the work. Furnish watertight connectors, with midget ferrule type fuses.

703.06.2 Signal Cable. Furnish cable meeting the International Municipal Signal Association (IMSA) Specification No.19-1 or 20-1.

Individual conductors must be stranded copper.

Use spade-type connectors.

703.06.3 Detector Loop Shielded Cable. Use cable as a lead-in between the loop pull box and the loop detector as specified.

Furnish with an aluminum-polyester shield with two AWG No.14 stranded, tinned, polyethylene-insulated copper conductors, a stranded and tinned copper AWG No.18 or 16 drain wire, all encased in a black polyethylene jacket meeting IMSA Specification No.50-2.

Ground the drain wire at the controller cabinet and dead end where the cable connects to the loop wires.

Make cable to loop wire connections within the pull boxes or signal standards with soldered, waterproof splices.

No other splices are allowed.

703.06.4 Emergency Preemption Detector Cable. Run the cable from the detector head to the discriminator.

Follow the preemption manufacturers recommendations for detector cable connections at the discriminator and detector head.

No splices are allowed in the cable.

703.07 SERVICE AND CONTROL ASSEMBLY. Equip and locate service and control assemblies as shown on the plans. Meet the Code and local utility company requirements.

Furnish cabinets meeting NEMA Type 3, 3R, or 12, made of aluminum or code-grade steel having a hinged, lockable door.

Furnish the Project Manager three keys to the lock.

Include a terminal strip having the number of attaching points for the required conductors with the service and control assembly. Assure the terminal strip has the capacity equal to an AWG No. 6 conductor. Run a bare AWG No.6 solid copper ground wire from the cabinet to a ⅝-inch (16 mm) by 8 foot (2.4 m) copperweld ground rod and clamp, as shown in the plans.

Provide all steel conduit, ground wire, insulated clevis, service wire, all mounting hardware and fittings to complete the work.

Construct photoelectric controls and their associated wires meeting Subsection 703.14 requirements.

703.08 SIGNAL CONTROLLERS.

703.08.1 General. Furnish traffic signal equipment meeting the National Electrical Manufacturer's Association (NEMA) Standards Publication No. TS 1-1976 through TS 1-1989 for traffic control systems.

The equipment must also comply with the Radio Manufacturers Association, National Electric Code, ASTM, ANSI, MUTCD and state plus local requirements.

Warrant the entire cabinet and electronics to be free from defects in workmanship and material for six months from the date of installation. Replace any defective parts at Contractor expense.

Assure a signal controller and cabinet manufacturer's representative is present at the signal turn-on to provide technical assistance in setting up, checking out, and demonstrating that the signal meets functional requirements.

703.08.2 Traffic Actuated Controller. Furnish a controller that is a micro-processor based solid state traffic responsive machine that provides 4 pedestrian phases and 4 vehicle phases for the Type 4-A-SS, and 4 pedestrian phases and 8 vehicle phases for the Type 8-A-SS. The 4-A-SS must have two programmable phase overlaps and the 8-A-SS must have four programmable phase overlaps.

The basic elements for the controller must be on modules that are plug connected to the main frame assembly and interchangeable between Traconex controllers. The controller must have an RS232 port capable of upload, download, modem connection, using a DB25 system connector.

The controller must have an internal time clock to enable outputs such as coordination, flash, dial, split, and offset choices. Timing must be accomplished by digital methods and utilize the power line frequency as a base. All automatic time corrections or synchronization except from power outages must be made at 12:00 midnight.

The controller must have an internal coordinator capable of being a master or slave with the appropriate inputs/outputs for 6 dials, 3 splits, and 3 offsets. Coordination must not interfere with non-coordinated signal operation when any other NEMA controller with the same number of phases is substituted.

Assure each phase has identical control capabilities, features, and options. The options and features for each phase must be able to be exercised independently of the options and features exercised on other phases. All controller unit timing intervals and phase options must be programmable from the front panel via a keyboard pad without the use of tools or special auxiliary units. The controller must be menu driven with an LCD display having at least 4 lines, 40 characters long.

The front panel must display the following information:

1. Presence of Vehicle Calls and Actuations on each phase;
2. Presence of Pedestrian Calls on each phase;
3. Termination of phase because of Gap-Out;
4. Termination of phase because of maximum Time-Out or Force-Off;
5. Maximum 2 in effect;
6. Phase Timing;
7. Phase Next;

8. Interval Timing;
9. Time remaining in interval;
10. Hold in effect;
11. Controller at rest;
12. Preemption.

The front panel must permit programming the following functions and display their status:

1. Phases that are to be enabled for the specific intersection configuration;
2. Concurrent pedestrian phases that are to be enabled for the specific intersection configuration;
3. Flashing or steady walk outputs per phase;
4. Phase that is to rest in walk if there are no conflicting calls;
5. Phases that guarantee timing of the pedestrian clearance intervals when under manual control;
6. Phases assigned to non-actuated #1 and #2 inputs;
7. Start up phase and phase indication;
8. Start up flashing time;
9. Phase Overlaps.

Overlaps must be programmable from a NEMA overlap card or from the front panel. The programming must consist of assigning the overlapped phases to the respective overlap.

It must be able to display previously programmed data stored in the controller from the front panel. The parameter called for and its current programmed value must be displayed without interruption of the controllers cyclic operation. It must be possible to change any programmed values while the controller is operating.

All display indicators must have a minimum design life of 20,000 hours at the rated voltage.

A. **Cabinet.** The controller and auxiliary equipment making up the rest of the controller unit with the exception of the preemption detectors and their lead-in cable must be housed in a weatherproof cabinet. Furnish a NEMA Type 3R rated and UL listed cabinet.

Fabricate the cabinets from sheet aluminum at least 0.125-inches (3.2 mm) thick, adequately reinforced, and weatherproof. The cabinet exterior must have a factory-applied prime coat and grey powder coated finish. The cabinet interior must have a white finish.

Provide the main cabinet door with a handle and a tumbler lock keyed for a Corbin #2 key. Equip the auxiliary door with a lock for a standard police key. Furnish two keys for each lock. The door must lock automatically when the door is closed and latched, with the key removed.

Furnish the cabinet with a door stop assembly to hold the door open at approximately 90° and 150°.

Cabinet sizes are as follows:

"H" Cabinet: Pole mounted cabinet.
Minimum dimensions: 42-inches (1066 mm) high x 26-inches (660 mm) wide x 17-inches (430 mm) deep.

"M" Cabinet: Pedestal mounted cabinet.
Minimum dimensions: 51-inches (1295 mm) high x 30-inches (765 mm) wide x 17-inches (432 mm) deep.

"P" Cabinet: Pedestal mounted cabinet.
Minimum dimensions: 56-inches (1422 mm) high x 44-inches (1118 mm) wide x 26-inches (660 mm) deep.

Furnish two anchor bolts with "M" cabinets. Furnish 4 anchor bolts with "P" cabinets. Furnish two washers and one nut with each bolt. Furnish bolts meeting the manufacturer's recommendations. Furnish hardware to pole mount the "H" cabinets.

Equip cabinets with an electric fan rated at 100 cfm (2.8 m^3/min.) minimum. Mount the fan in the top of the cabinet in a manner that prevents rain from entering. The fan must be thermostatically controlled and manually adjustable to turn on between 70 °F (20 °C) and 150 °F (65 °C). Fuse the cabinet fan circuit 125% of the capacity of the fan motor.

Furnish the cabinet with louvered filtered vents in the front door. Mount a removable air filter with a metal retainer spring inside the cabinet door behind the louvered vents.

Mount an incandescent lamp on the inside top of the cabinet, near the door. The lamp must provide illumination whenever the cabinet door is open. Florescent lamps are not acceptable.

Equip cabinets with a 150-watt strip heater with a variable adjustable thermostat on a separate circuit breaker and switch.

Supply 4 copies of the cabinet wiring diagram, 1 copy of the operating manual for each device, and 1 copy of the manual for controller P. C. software. Place the wiring diagram in a heavy duty clear plastic pouch, attached to the inside of the main cabinet door. This pouch must be of a material and design that it provides storage and access to the wiring diagram.

Submit a schematic wiring diagram of the controller and auxiliary equipment before purchasing. This diagram must detail all circuits and parts. Identify the parts shown by name or number. Furnish parts that are readily available and non-proprietary.

B. Cabinet Wiring. The cabinet wiring must provide the following services:

Cabinets must have interface panels capable of terminating a 12 conductor wire 120 volt interconnect and 4 conductor telemetry. A master cabinet must have a relay driven 120 volt panel. A slave cabinet must have a solid state 120 volt panel. This interface panel must provide the following functions:

1. Offset 1
2. Offset 2
3. Offset 3
4. Dial 2
5. Dial 3

6. Dial 4
7. Flash
8. Split 2
9. Coordination/Free
10. Split 3
11. AC common from Master
12. Spare

Wire cabinets with a plug-in mounted (solid state) flasher, and jack mounted relays to permit any combination of flashing red or yellow lights. Operation shall cut in flasher and isolate controller from signal light circuits. The NEMA flash circuit must not be controlled by the controller.

Furnish a readily accessible mounting panel in each controller cabinet with provisions for terminating all field circuits.

Wire "H" cabinets for 6 load switches, (4 vehicle and 2 pedestrian). Wire "M" cabinets for 9 load switches, (4 vehicle, 4 pedestrian and 1 overlap). Wire "P" cabinets for 14 load switches, (8 vehicle, 4 pedestrian and 2 overlap).

Terminate the spare output circuits of pedestrian load switches on field terminals for future use.

The cabinet must include a police panel with the following switches:

Switch	**Function**
Auto-Flash	The Flash position shall place the intersection in Flash and turn the conflict monitor and Opticom off and stop time the controller. Assure the controller begins its mode of operation in the startup routine upon return from the Flash position to the Auto position.
Main Switch	The On position shall provide normal operation. The Off position shall remove power from the cabinet, with the exception of the convenience outlet.

Include an auxiliary test panel with the following switches for the cabinet:

Switch	**Function**
Auto-Flash	The Flash position shall place the intersection in Flash and allow the controller and auxiliary equipment to operate.
Stop-Time	The On position shall apply stop timing to (On-Off-Auto)the controller. The Auto position shall allow the conflict monitor or other external source to apply stop timing to the controller. The Off position shall remove any external stop timing applied to the controller.

Each phase shall have vehicle and pedestrian push buttons to place calls on the phase. Six for "H" cabinets, 8 for "M" cabinets, and 12 for "P" cabinets.

Include a 15 amp fused convenience ground fault outlet with the auxiliary test panel. Wire the outlet so it remains functional even with the main switch or main circuit breaker in the off position.

The cabinet must contain an input power panel with the following:

1. Main Circuit Breaker: 40 Amp for 4-A-SS, 50 Amp for 8-A-SS
2. 20 Amp Auxiliary Equipment Circuit Breaker
3. 50 Amp RIS
4. Transient Voltage Protector
5. Neutral Bus Bar
6. Base-Mounted MOV rated at 70 joules or greater
7. Ground Bus Bar
8. 50 Amp Mercury Contactor
9. Gas Tube Lightning Arrester

Wire a transient voltage protector into the cabinet.

The power input for the controller, conflict monitor and other control equipment, exclusive of the flasher circuitry, must come from the transient voltage protection device that protects against abnormalities of less than one-half cycle duration. The protector must be a solid state high energy circuit containing no spark gap, gas tube or bar component.

The devices current rating must equal or exceed 15 amps.

The protection must be a transient suppression of 200 volts peak, a transient response of less than five nanoseconds, a power dissipation of 10,000 watts, and an overvoltage response of five seconds. The protector must function with a 10 x 1000 microsecond wave form clamping no greater than 200 volt peak.

Wire cabinets to provide for a conflict monitor. Provide cabinet interlock circuitry which automatically places the intersection signals on flashing operation if the conflict monitor is disconnected while the controller is operating the signals and the cabinet door is closed.

Wire cabinets for rack mount vehicle detectors. "H" and "M" cabinets must have a 6 position rack. "P" cabinets must have a 10 position rack. Assign rack slots with slot 1 being for phase 1 detector, slot 2 for phase 2 detector with other slots following this example. Reserve slots 5 and 6 for Opticom in "H" and "M" cabinets. Reserve slots 9 and 10 for Opticom in "P" cabinets. Equip all racks with an external wall mount fused +24 volt DC regulated power supply rated at 2.4 amps.

Install a panel mounted on the lower left side of the cabinet having terminals to terminate loop lead-in cables and up to 4 pedestrian push button lead-in cables for the type 4-A-SS and 8-A-SS controllers.

Pin assignments for the 4th connector are as follows:

PIN	FUNCTION	I/O	ADDRESS BIT
1	Emergency Preempt 4 Out	O	$62-3
2	Offset 3 Out	O	$61-2
3	Offset 4 In (Add Bit 3)	I	$61-3
4	ON LINE	I	$61-5
5	Spare	O	$62-7
6	Dial 4 In	I	$60-3
7	Dial 6 In	I	$60-5
8	Special Function 2 Out	O	$61-6
9	Split 3 In	I	$60-7
10	Offset 2 In (Add Bit 1)	I	$61-1
11	Flash Out	O	$62-6
12	Offset 1 In (Add Bit 0)	I	$61-0
13	System Detector 8	I	$63-7
14	Dial 5 In	I	$60-4
15	Special Function 3 Out	O	$61-7
16	Split 2 In	I	$60-6
17	System Detector 1 (Seq #1)	I	$63-0
18	System Detector 4 (Seq #4)	I	$63-3
19	System Enable	I	$61-6
20	Dimming On	I	$61-7
21	Split 2 Out	O	$60-6
22	Emergency Preempt 2 Out	O	$62-1
23	Railroad Preempt Out	O	$62-4
24	Spare	O	$62-5
25	Dial 2 In (Special Function 2)	I	$60-1
26	Coordination On (Special Function 1)	I	$60-0

PIN	FUNCTION	I/O	ADDRESS BIT
27	Coordination Out	O	$60-0
28	Special Function 1 Out	O	$61-5
29	Dial 4 Out	O	$60-3
30	System Detector 5 In	I	$63-4
31	System Detector 3 (Seq #3)	I	$63-2
32	Emergency Preempt 1 Out	O	$62-0
33	Offset 1 Out	O	$61-0
34	Emergency Preempt 3 Out	O	$62-2
35	Dial 3 In (Special Function 3)	I	$60-2
36	Offset 3 In (Add Bit 2)	I	$61-2
37	Flash Status In	I	$62-7
38	Offset 5 In (Add Bit 4)	I	$61-4
39	System Detector 6 In	I	$63-5
40	System Detector 7 In	I	$63-6
41	Offset 4 Out	O	$61-3
42	Offset 2 Out	O	$61-1
43	Dial 2 Out	O	$60-1
44	Dial 3 Out	O	$60-2
45	Offset 5 Out	O	$61-4
46	Split 3 Out	O	$60-7
47	System Detector 2 (Seq #2)	I	$63-1
48	Logic Ground		
49	Emergency Preempt 1 In	I	$62-0
50	Emergency Preempt 2 In	I	$62-1
51	Dial 5 Out	O	$60-4
52	Dial 6 Out	O	$60-5
53	Logic Ground		

PIN	FUNCTION	I/O	ADDRESS BIT
54	Logic Ground		
55	Emergency Preempt 3 In	I	$62-2
56	Emergency Preempt 4 In	I	$62-3
57	Railroad Preempt In	I	$62-4
58	Conflict Status In	I	$62-5
59	Reserved		
60	Flash Command In	I	$62-6
61	Reserved		
62	Reserved		
63	Chassis Ground		

Wire cabinets for Opticom emergency preemption equipment. Provide interface terminals for two Model 562 discriminators wired as follows:

4-A-SS	
Discriminator #1	Channel A = Ø1
Discriminator #1	Channel B = Ø3
Discriminator #2	Channel A = Ø2
Discriminator #2	Channel B = Ø4
8-A-SS	
Discriminator #1	Channel A = Ø1 & Ø6
Discriminator #1	Channel B = Ø3 & Ø8
Discriminator #2	Channel A = Ø2 & Ø5
Discriminator #2	Channel B = Ø4 & Ø7

Provide the necessary logic and wiring to allow the following operation:

1. Immediate advance of the controller to the clearance intervals of the phase timing.
2. All clearance intervals to be timed as set on the controller.
3. After proper clearances the controller shall go directly to the preempted phase bypassing any intervening phases in the normal sequences.
4. During preemption all pedestrian indications to hold in DON'T WALK.
5. Following preemption, place a minimum vehicle recall on all phases.

The Opticom interface panel must provide terminations for up to 4 Model 521 Opticom detectors for the type 4-A-SS and 8-A-SS controllers. One detector must be assigned to correspond to each of the channels available on the discriminator.

Mark all wiring for easy identification. Use permanent labels.

703.08.3 Conflict Monitor. Furnish a self-contained solid state conflict monitor able to detect the presence of conflicting signal indications and the absence of proper voltage at the field connection terminals of the red signals. It must be able to monitor for the presence of proper operating voltages in the controller and also within itself.

The conflict monitor must monitor switch fail conditions, inadequate yellow timing and have serial communications for a printer or computer.

Furnish a type 6 or 12 conflict monitor with respect to the corresponding type 4-A-SS or 8-A-SS controller. It must monitor the Green, Yellow, Red and Walk of each phase.

The front of the monitor unit must contain the MS connector, AC+ power fuse, power indicator, reset switch, signal conflict and Red failure indicators, +24 Volts DC #1 and #2 indicators, controller voltage failure indicator, signal status indicators for each channel, universal removable programming card, initial flash time adjustment control, a RS232 serial communications port, and an LCD display indicating which input on each channel is the conflicting display. All indicators must be LED type.

If a conflict monitor channel is used, bring out all unused inputs to a terminal for future use.

703.08.4 Flasher.

Furnish a solid state electronic flasher producing between 50 and 60 flashes per minute with equal on-and-off time intervals meeting all NEMA Type 3 requirements and conforming to part 4B-18 of the MUTCD.

703.08.5 Solid-State Load Switches. Accomplish switching of signal lights (external to the controller mechanism) by using solid state switching assemblies. Furnish a load switch meeting all NEMA requirements as to the type. Supply 8 load switches with each type 4-A-SS controller. Supply 12 load switches with each 8-A-SS controller.

703.08.6 Loop Detectors. Furnish two channel loop detectors of the rack mount type.

The loop detectors must be solid state digital using external power. The front panel must contain sensitivity controls, mode selector switch, and an actuation indicator LED.

The loop detectors cannot not use more than 150 MA of current at 24 volts DC. The output must be by relay and plug mounted. The relay must be normally energized providing fail-safe functioning should the power fail. Furnish loop detectors meeting all NEMA temperature requirements. Use a 44 pin edge card connector to make all electrical connections.

Supply 4 loop detectors with each type 4-A-SS controller.

Supply 8 loop detectors with each type 8-A-SS controller.

703.08.7 Railroad Interconnect. Where railroad interconnects to railroad circuits are specified, the railroad company will furnish a set of normally closed contacts in the railroad cabinet. Perform the traffic signal cabinet to railroad signal cabinet interconnect. Run the circuit conductors in underground, rigid electrical conduit as specified in the Contract. Terminate the conduit in the railroad cabinet as directed by the railroad company engineer. Leave the wire ends projecting at least 3 feet (0.9 m) beyond the end fitting inside the railroad cabinet. The railroad will perform all work inside the railroad cabinet. Do not begin work within the railroad right of way without the Engineer's approval. The Engineer will obtain the railroad's approval and notify the Contractor. The railroad may provide any inspection necessary to oversee

the Contractor's work on railroad right of way. Railroad inspection costs are at Contractor expense.

Observe the railroad special clearances found elsewhere in the contract.

Furnish solid state railroad preemption devices meeting the following requirements:

A. **Signal Operation Preempted by Train.** Any vehicle signal displaying a green shall immediately receive a yellow clearance. The yellow clearance time may be controller-timed or by other timing device with a range of between 0 to 60 seconds.

Any vehicle signal displaying a yellow shall continue to time out the controller-set time or switch to an adjustable timer separate from the controller.

All pedestrian signals shall immediately receive a "DON'T WALK" call.

If vehicle signals are in emergency flashing, they shall remain flashing with the preemptor disconnected from the circuit.

Upon train pre-emption, a red signal shall always be presented to approaching traffic in advance of the tracks.

The signal phasing during railroad preemption is specified in the contract.

B. **Signal Operation After Train Passage.** A signal call for "Green" and/or "Walk" shall be placed on each phase for normal operation once the train has passed.

Any signal having the "Green" indication shall receive a yellow clearance indication. The indication shall be timed on the controller phase or other adjustable timer with limits of 0 to 30 seconds.

Once the yellow clearance interval is timed out the controller shall revert to normal operation unless a special sequence is specified.

703.09 TYPE "D" CABINET PEDESTAL. Locate the pedestal as specified or directed. Construct the pedestal, including the concrete work, as specified.

703.10 TRAFFIC AND PEDESTRIAN SIGNALS.

703.10.1 Traffic Signal Heads. Furnish traffic signals meeting or exceeding the Traffic Engineers Technical Report No. 1, USAS D010.1-1966, UDC 656.057, or latest revision thereof. Use AWG No. 14 conductor between the signals and terminal block meeting Subsection 703.06.1. Supply the conductor as a part of this work.

A. **Optical Units.** Furnish the optical unit consisting of a lens, reflector, lamp holder, and 120 volt, clear, 6,000-hour-life, traffic signal lamp. Furnish 116 watt lamps for 8-inch (205 mm) lenses and 150 watt for 12-inch lenses (305 mm).

Furnish the lens color and size specified in the Contract. Use a polycarbonate traffic signal lens true to color.

Furnish an "Alzak" Type reflector.

B. **Signal Housing.** Assemble the signal head housing sections together in a watertight assembly. Each section must house an individual optical unit complete with a one-piece hinged door, a mounting for the lens and other optical system parts, watertight gaskets, and a non-corrodible door-lock.

Mount the optical system so the individual components swing open for access or removal. Assure sections are interchangeable and constructed so sections can be added or removed. Each section must have a round opening in the bottom and top to receive a 1½-inch (38 mm) supporting pipe frame. The housing, including the doors and end plates must be die-cast aluminum, clean and smooth, free from flaws, cracks, blow holes, or other imperfections. Hinges, pins, lens clips, and locking devices shall be non-corroding metal.

Mount a terminal block inside at the back of the housing. Wire all sockets with a white wire connected to the socket shell and a black wire to the bottom or end terminal of the socket. Connect these wires to the terminal block mounted in the housing.

The terminal block must have studs to terminate all field wires and lamp wires independently. Permanently identify the terminals.

Where terminal compartments are used, terminal blocks in the heads may be omitted.

Supply with each lens a removable tunnel visor (open bottom) of the appropriate size made from at least 0.050-inch (1.3 mm) thick aluminum.

The inside surface of all visors shall be flat black.

C. Back Plates. Furnish and install back plates on all traffic signal heads to form a 5-inch (130 mm) border around the signals. Make backplates from at least 0.058-inch (1.5 mm) sheet aluminum. Paint back plates under Subsection 617.03.12.

D. Mounting Brackets. Mount signal heads using brackets made from 1½-inch (38 mm) standard steel pipe and malleable iron or brass pipe fittings. Plumb or level all elements , symmetrically arrange, and securely assemble. Conceal all conductors in the poles and assembly. At each signal location, construct a terminal compartment in the bracket system as shown on the plans. Bracket mounted signals that are post top mounted must have a terminal compartment cast with an integral slip-fitter. For post-top mounted one-way signal head, a slip-fitter without a terminal compartment may be used. Fit the slip fitter over a 4-inch (105 mm) standard pipe. Provide each slip-fitter with 2 rows of 3 set screws in each row to plumb the assembly. Use cadmium plated set screws. Signal heads mounted on luminaire standards or other tall poles must have a terminal compartment to bolt or clamp securely to the pole.

Provide each compartment with a terminal block with twelve terminals, each with two pressure type connectors. Size each connector to accommodate at least five No. 14 conductors.

Provide the terminal compartment with an access opening to the terminal block with a rain-tight cover. All slip-fitters and terminal compartments must be made of non-frangible metal.

E. Signal Head Mounting. Mount signal heads as shown on the plans. Use the standard mounting for all three-section mast arm mounted signals, unless 17.5 feet (5.3 m) of roadway clearance cannot be obtained. Use an elevator plumbizer, when necessary, to obtain the 17.5 foot (5.3 m) clearance.

Elevator plumbizer mount all four and five section signals.

Use internally wired plumbing devices for mounting signal heads to mast arms.

Provide positive lock rings and fittings for all signal heads. Use rings and fittings with serrated contacts.

F. **Installing Signal Heads.** Install signal heads after all other signal equipment is placed and ready for operation, or cover the signal faces with an opaque covering.

G. **Directional Traffic Signals.** The traffic signals must be optically-programmed and visible only to a specific area of the intersection.

Use 150-watt PAR lamps for optically-programmed signal lamps.

Furnish back plates, mounting brackets, installation, and mounting meeting Subsections 703.10 (C),(D),(E),(F) and (G).

703.10.2 Pedestrian Signals. Furnish pedestrian signals rectangular in shape containing the letter messages "WALK" and "DON'T WALK" or the international symbols as specified. Letters must be at least 4½-inches (115 mm) high. Furnish international symbols a minimum of 9" (230 mm) high. If, due to electrical or mechanical failure, the word "DON'T fails to illuminate in the "DON'T WALK" lens the signal must not illuminate the word "WALK".

Furnish one piece, watertight, cast aluminum housings with a polycarbonate lenses.

Furnish mounting hardware for pedestrian signals and mount as shown in the Contract and meeting Subsection 703.10.1(D) requirements.

Furnish a terminal compartment with the frame-work for each signal mounting.

Provide AWG No.14 conductors meeting Subsection 703.06.1 from the signals to the terminal compartment as a part of this work.

Use pedestrian signals of the same type within each intersection.

Furnish lunar white "WALK" lens. Furnish portland orange "DON'T WALK" lens with both colors meeting the current requirements of the Institute for Traffic Engineers standards.

Furnish lamps of at least 116 watt, clear traffic signal type rated for 6000 hours of life at 120 volts.

703.11 LOOPS, LOOP DETECTORS, AND CABLE.

703.11.1 Loops. Size and install loops as specified in the Contract and to meet the following.

Use one continuous length of No. 12 XHHW wire from the pull box, through the loops and returning back to the pull box. The number of loops is shown on the plans. Twist the loop wires together at 3 turns per foot (305 mm) between the loop and pull box.

Place the loop wire in the saw-cut slot, pour sealant into the slot encapsulating the wire, and fill the slot level to the pavement surface. Sealant must not require a primer.

Sealant must have a non-critical mix ratio allowing application and cure at ambient temperatures of 40 °F (4.4 °C) or higher.

Cured sealant must withstand heavy vehicle traffic and freeze-thaw cycles, be unaffected by water, gasoline, oils, roadway salts, and most corrosive chemicals.

Repair saw cuts through existing pavement markings as directed.

Clean the saw cut slot by high pressure air before placing the loop and sealant.

Make loop wire connections in pull boxes or signal standards using soldered, waterproof splices. Excess make-up wire or lead-in or loop wire coils is not permitted.

Tag loop wire in the pull box, or signal standard if spliced there, with a permanent wire marker indicating the approach, loop number, and "input" or "output".

703.11.2 Loop Detector. Furnish loop detectors meeting NEMA requirements and Subsection 703.08.6.

703.11.3 Detector Loop Shielded Cable. Furnish cable meeting Subsection 703.06.3.

703.12 PEDESTRIAN PUSH BUTTONS. Furnish and install tamper-proof pedestrian push buttons having a direct push button with a single momentary contact switch in a cast-metal housing. The push button must be raised or flush with the housing and be at least 2-inches (50 mm) in the smallest dimension. The push button must activate with less than 5 lbs (22 N) of push force. The push button housing must be weatherproof, and electrically insulated to prevent shock under all weather conditions. Furnish a housing back plate to fit the pole curvature and, when required, provide saddles to make a near fit. Furnish and install push button signs shown on the plans. Install the push button and sign on the crosswalk side of the pole with the arrow pointing in the direction of the crosswalk.

Field drill and tap signal standards treating the holes with a rust preventative following the manufacturers directions.

703.13 LUMINAIRES. Furnish and install luminaires and lamps meeting these specifications and the contract requirements.

Wire all luminaires for 240-volt operation.

Ballasts and luminaire must be integral, with the ballast providing -20 °F (-29 °C) starting capacity. Multiple ballasts must be 240 volt regulated lag type, .90 power factor, with an operating range of ± 10 percent. Starting and open circuit volt-amperes must not exceed operating values.

Furnish the unit with an independent, replaceable starting board.

The luminaire assemblies must be slip-fitter type, end mounted on a 2-inch (50 mm) pipe tenon.

Check luminaires on the ground to insure they provide the specified ANSI/IES light distribution pattern before mounting. Adjust the luminaires at night, as directed, to provide the best roadway light distribution.

703.14 PHOTOELECTRIC CONTROLS. Wire photoelectric controls to meet the contract requirements.

Furnish photoelectric control units of the twist-lock type.

The units shall turn on at 1.3 ± 0.5 foot candles, have a turn-on/off ratio in the range of 1:2 to 1:5 and be rated for a minimum of 1,000 watts at 120 volts.

Incorporate a time delay mechanism into the control preventing operation during brief light condition changes.

Provide a fail safe that leaves the load on or becomes energized if the control fails.

Mount the control at the top of the standard with the photo cell oriented toward the north sky or as directed.

Use AWG No. 14 conductor meeting Subsection 703.06.1 between the photoelectric controller and the electrical service. Supply the conductor as part of this work.

703.15 EMERGENCY PREEMPTION SYSTEM. Emergency preemption equipment must be directly interchangeable and compatible with Opticom emergency preemption equipment. Furnish Opticom model 562 discriminators.

Furnish a system using a high-intensity light source to beam a coded message from the emergency vehicles to the detectors at the intersection.

The system will hold the green light in favor of the emergency vehicle or accelerate the normal cycle of the signal change, within NEMA Standards Publication No. TS 1-1976, to provide a standard yellow light clearance, and then a red light stopping traffic across the emergency vehicle path.

When emergency preemption detector cable is included in the system use the cable recommended by the manufacturer or cable meeting Subsection 703.06.4 requirements.

Assure a preemption equipment factory representative provides technical assistance in setting up, checking out, and demonstrating that the system meets functional requirements.

703.16 CLASS 4 TREATED TIMBER POLES. Furnish the pole length and place as specified in the Contract.

Furnish class 4, machine peeled poles with 8 feet (2.4 m) of the butt treated with a 5% solution of pentachlorophenol. Seat, backfill, and compact around the poles. Compact backfill in 9-inch (230 mm) lifts. Plumb and rake the pole as directed.

703.17 OVERHEAD CONDUCTOR LIGHTING INSTALLATION.

703.17.1 Luminaire. Furnish luminaires meeting Subsection 703.13 requirements.

703.17.2 Lighting Brackets. Furnish brackets as shown in the Contract that meet or exceed NEMA and IES standards for vertical and horizontal deflection. Use AWG No. 10 copper wiring insulated for 600 volts between luminaire and ballast secondary.

703.17.3 Wood Poles For Overhead Conductor Highway Lighting. Furnish wood poles meeting ANSI specifications. The poles must be straight so that a line drawn from the butt center to the top center will pass through the pole body. The

poles must be machined-peeled and set to the ANSI recommended depth. Set poles plumb and true to line. Compact backfill in 9-inch (230 mm) lifts.

Pressure treat the bottom 8 feet (2.4 m) of the poles with a 5-percent by weight pentachlorophenol solution or Chromated Copper Arsenate (CCA), type B or C, or Ammoniacal Copper Arsenate (ACA) meeting AWPA standards and Section 706 requirements.

Repair pole finish damage as directed.

703.17.4 Steel Poles for Overhead Conductor Highway Lighting. Furnish steel poles meeting Subsection 703.04.3 and 703.04.4 requirements.

703.17.5 Line Material. Furnish all line material that meets the Contract requirements and the following.

Furnish insulators for brackets, clevises and upset bolts of the wet process type, 3-inch (75 mm) diameter X 3/16-inch (5 mm), 5/8-inch (16 mm) bolt hole having a 7/16 (11 mm) radius wire slot, and vertical mounting. It must be rated for wet flashover of 14KV, horizontal mounting wet flashover 17KV, dry flashover 26KV, and ultimate mechanical strength of 5,000 pounds (2,270 kg).

Furnish double upset bolts of 9/16-inch (14 mm) steel with 5/8-inch (16 mm) rolled threads, 1½-inch (38 mm) upset to upset, and 4½-inch (115 mm) threaded insulator end with cotter key.

Use insulated brackets that are spool clevises of the cross arm mounting type constructed of 1¾ X ⅛-inch (45 X 3 mm) steel providing a ¾-inch (19 mm) mounting hole and a 5/8-inch (16 mm) cotter pin for mounting the insulator. The clevis must provide a 5-inch (130 mm) distance from the center of the insulator to the mounting face.

Furnish insulated swinging clevises of 1½ X 3/16-inch steel (38 X 5 mm), 5-inches (130 mm) from 5/8-inch (16 mm) cotter pin to eye attachment for 3-inch (75 mm) insulator and 5/8-inch (16 mm) eye-bolt or eye-nut.

Furnish copper to copper connectors of high strength silicon bronze threaded with spacer and nut. Use aluminum to copper connectors of an aluminum-alloy bolt and nut with a plated copper spacer and plated copper contact. Remove the plating from the contact surfaces to identify the copper conductor location.

Insulated tension splices must have a 4-inch (100 mm) insulated length. Size the tap wire attaching clips for the appropriate wire size being installed. Obtain the Project Manager's approval before installation. Use insulated tension splices where required, in series installations, as follows:

1. Do not locate splices closer than 18-inches (460 mm) from a support point.
2. Do not locate splices in spans crossing a highway, street, or railroad.

Do not use conductor with cuts, kinks, or other injuries.

On angle assemblies, place the conductors on the insulator side away from the strain and tie it in place as shown on the plans. Sag all wire with the Project Manager present who will provide the sag tables. Provide an approved thermometer for the temperature reading. Gradually pull the wire to the required sag, keeping the wire free to move at intermediate support points. Do not pull wire beyond the required sag.

703.17.6 Guys and Anchors. Install guys and anchors as specified. Use two strain insulators in all guy spans. Use Eye-bolts, eye-nuts, and anchor rods with thimble eyes when used on guys. Furnish eye-bolts and eye-nuts used on down guys of the 45° angle type.

Use ⅜-inch (9.5 mm) Siemens-Martin seven strand, galvanized guy wire meeting ASTM A 363.

Use three medium duty bolt clamps where necessary. Draw all three bolts up tight. Clamps using a stainless steel bail for straight through dead ending of the guy wire are an acceptable alternate to guy clamps.

Furnish 8 feet (2.4 m) long, full round gauge 14 galvanized steel guy protectors.

Use strain insulators meeting the following:

Rated Voltage, KV	4.4
Flashover Voltage: 60 CY, Dry KV	30
60 CY, Wet KV	15
Mechanical Strength, Pounds	12,000 (53.3 kN)
Max. Cable Size, Inches	½" (13 mm)
Length, Inches	4-⅛" (105 mm)
Width, Inches	2-⅞" (73 mm)

Provide anchors and rods as specified. Install in line with the strain and installed with approximately 6-inches (155 mm) of the rod projecting out of the ground. Backfill the hole with course crushed rock 2 feet (610 mm) above the anchor, compacting in 6-inch (155 mm) lifts for the full depth.

SECTION 704
SIGNING MATERIALS

704.01 MATERIAL FOR SIGNS.

704.01.1 Sheet Aluminum. Use aluminum alloy meeting the Aluminum Association alloy AA5052-H38 or AA6061-T6 requirements. Meet the sheet thickness requirements in Table 704-1.

TABLE 704-1
SINGLE POST CENTERLINE MOUNTING
WITHOUT BACK BRACING

REGULATORY SERIES	
Sign Size	**Metal Thickness**
0" to 33" inclusive (0 to 838 mm)	0.080 in (2 mm)
34" to 41" inclusive (864 to 1,041 mm)	0.100 in (2.54 mm)
42" to 51" inclusive (1,067 to 1,295 mm)	0.125 in (3.17 mm)
WARNING SERIES	
30 X 30 in or smaller (762 X 762 mm)	0.080 in (2 mm)
36 X 36 in (914 X 914 mm)	0.080 in (2 mm)
48 X 48 in ((1,219 X 1,219 mm)	0.100 in (2.54 mm)
60 X 60 in (1,524 X 1,524 mm)	0.125 in (3.17 mm)
ALL SIGNS WITH BACK BRACING	
Maximum Back Brace Spacing	**Sign Sheet Thickness**
< or = 32 in. (813 mm)	0.080 in. (2 mm)
< or = 40 in. (1,016 mm)	0.100 in. (2.54 mm)
< or = 50 in (1,270 mm)	0.125 in. (3.17 mm)
DELINEATOR REFLECTORS	
All sizes	0.063 in (1.6 mm)

Use the sheet thickness shown in the regulatory series for the route marker series, using the widest point on the cut-out shield for the width dimension.

704.01.2 Aluminum Sheet Increment. Construct Aluminum sheet increment signs using AA5052-H38 or AA 6061-T6 sheet aluminum (thickness in Table 704-1) fastened to an extruded T-section (AA6063-T6) backbrace with 3/16-inch (5 mm) blind rivets. Use the backbrace and rivet spacing shown in the Detailed Drawings. Use extruded T-sections weighing a minimum 0.88 lbs/linear foot (1.3 kg /m) with a minimum moment of inertia about the neutral axis of 0.40 inches^4 (166.5 mm^4).

704.01.3 Plywood. Use Douglas Fir meeting the "Commercial Standard 45 for Douglas Fir plywood", B-B high density overlay, 60/60 with plastic overlay, both sides, ¾-inch (20 mm) thick. Do not use plywood on multiple post installations.

704.01.4 Aluminum and Steel Posts.

A. General. Furnish posts meeting the Contract requirements. Treat steel post field cuts and holes with one coat of metal primer and two coats of aluminum paint. Coat galvanized posts meeting AASHTO M 111 specifications.

B. Steel Posts.

1. **Structural Steel.** Furnish structural steel posts with a nominal weight exceeding 3 pounds per foot (4.5 kg/m) meeting ASTM A 36 requirements. Bid these posts as "steel structural sign posts".
2. **Steel U Sign Posts.** Furnish steel posts formed into a "flying U " shape with a nominal weight exceeding 3 pounds per foot (4.5 kg/m) meeting AASHTO M 281. Bid these posts as "steel U sign posts".
3. **Tubular Steel Posts.** Furnish round tubular steel posts meeting ASTM A 53 Type E or S, Grade B requirements. Furnish square or rectangular tube posts meeting ASTM A 500 or 501 requirements. Painted or galvanized posts are acceptable. Meet ASTM A 123 requirements for galvanizing. Paint posts with a paint meeting Subsection 710.02 (B)(3) requirements. Paint the posts meeting the applicable requirements of Section 612.
4. **Square Tubular Steel Posts.** Furnish square tubular steel sign posts, anchor posts, anchor sleeves, and splice sleeves meeting one of the following requirements as specified in the Contract:
   - **a.** ASTM A-446 Grade A, steel in 10 or 12 gauge having a 33,000 psi (22.7 MPa) minimum yield strength and a 45,000 psi (31 MPa) minimum tensile strength.
   - **b.** ASTM A-570, steel in 12 or 14 gauge having a 60,000 psi (41.4 MPa) minimum yield strength and a 75,000 (51.7 MPa) minimum tensile strength.

   Use ASTM-A 307 Grade 2 bolts and nuts. The sign posts, sleeves, anchor posts, auxiliary fittings and anchor sleeves must have 7/16-inch (11 mm) diameter holes or knockouts on 1-inch (25 mm) centers on all four sides.

   The permissible pole straightness variation is 1/16-inch in 3 feet (1 mm per m) with the corner radius being 5/32-inch (4 mm) plus or minus 1/64-inch (0.4 mm).

C. Coatings. Coat the post with Type 2 aluminum paint at a minimum 0.75 ounces per square foot (228 kg per m^2) of surface area, measured by triple

spot testing under AASHTO T-213. Follow with a chromate conversion coating, and a thin acrylic or polymer resin film; or a triple coating of hot dipped zinc weighing 0.60 ± 0.15 ounces per square foot (183 kg ±4.3 kg per m^2) meeting AASHTO M-120, followed by a chromate conversion coating 15 ± 5 micrograms per square inch (645 mm^2), and a clear organic coating 0.2 ± 0.1 mils (0.005 mm ± 0.0025 mm) thick on the outside surface. Provide double in-line application of a full zinc-based organic coating 1.2 ± 0.6 mils (0.003 mm ± 0.0015 mm) thick tested under ASTM B-117 on the inside surface.

D. Aluminum U Posts. Furnish aluminum posts made of AA6061-T6 alloy extruded to a U channel meeting ASTM B 209.

704.01.5 Treated Timber Posts. Furnish treated timber posts of construction grade, S4S, full length pressure treated with a 5% by weight pentachlorophenol solution or Chromate Copper Arsenate (CCA), Type B or C, or Ammoniacal Copper Arsenate (ACA) meeting AWPA standards and Subsection 706.04.1. Perform all cutting, trimming and boring, excluding the breakaway hole, before treatment. Assure individual posts are uniform in color for each project. The posts will be inspected where treated.

Treat injuries, cuts, and holes in posts after treatment with 3 applications of copper napthenate solution containing a minimum 2% copper metal or with Chromate Copper Arsenate (CCA) meeting AWPA M4 requirements.

704.01.6 Treated Timber Poles. Furnish treated timber poles meeting ANSI Specification 05.1 and of the species listed in Table 4, 5, or 6. All poles on each project must be the same species and uniform in color after treatment. Machine-peel and full length pressure treat all posts with a 5% by weight pentachlorophenol solution or CCA (type B or C), or ACA as specified in Subsection 706.04.1. Gain each pole on the sign face as specified. Poles may be gained full-length, or half gained from the top.

Use pressure treated, construction grade, 2 X 4 (50 X 105 mm) in S4S for back bracing.

Treat poles, damaged, cut, or bored after treatment meeting Subsection 704.01.5 requirements.

704.01.7 Barn Poles. Barn poles are specified by the top diameter. Meet the following table top diameter limits:

Specified Top Diameter	Limits (diameter)	
	Min.	Max.
3" top (75 mm)	3" (75 mm)	< 4" (100 mm)
4" top (100 mm)	4" (100 mm)	< 5" (130 mm)
5" top (130 mm)	5" (130 mm)	< 6" (150 mm)
6" top (150 mm)	6" (150 mm)	< 7" (180 mm)

Furnish poles that are straight so that a line from center of tip to center of butt passes through the pole body from tip to butt. The poles must be free of crooks and

sweeps. Full length pressure treat all barn poles with a 5% by weight pentachlorophenol solution or Chromate Copper Arsenate (CCA), type B or C, or Ammoniacal Copper Arsenate (ACA) meeting AWPA standards and Section 706.04.1 requirements.

Treat damaged, cut, or bored holes in treated posts meeting Subsection 704.01.5 requirements. Gain each pole on the sign face at least 2-inches (50 mm) in width as specified. The post may be gained full length or half-gained from the top.

Use pressure treated, construction grade 2-inch X 4-inch (50 X 105 mm) in S4S for backbracing.

704.01.8 Overhead Structures. Furnish overhead sign structures meeting the current AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals and the Contract requirements.

704.01.9 Concrete. Use class "A" or "D" concrete meeting Section 551 requirements for steel sign post foundations. Hand mixing is not allowed. Add an air entraining agent to all foundation concrete.

704.01.10 Retro-reflective Sheeting.

A. General. Furnish the type of retro-reflective sheeting and color specified in the Contract. Meet AASHTO M 268 requirements for the type specified.

B. Acceptance. Submit a notarized manufacturer's certification that the retro-reflective sheeting used for each project meets or exceeds Contract requirements.

The Department may take sheeting samples for analysis and testing. The Project Manager may visually compare the sheeting's diffuse day color in the field using standard color charts and test the signs reflectivity using a reflectometer.

Replace rejected material at Contractor expense.

704.01.11 Letters, Symbols, and Accessories.

A. General. Furnish the material type(s) specified in the Contract. Use Type A, Type B, or Type C, described as follows.

B. Type A Letters using Acrylic Plastic Reflectors.

1. **Description.** Furnish Cutout letters, numerals, alphabet accessories, and border strips of embossed aluminum frames with prismatic reflectors installed or affixed as an integral part of the character. Do not use tape or adhesives to affix the reflectors.
2. **Design and fabrication.** Use the Federal Standard Alphabet Series "D" or " E modified " for character sizes, series, and spacing. Fabricate characters, borders, and accessory frames from minimum 0.040-inch (1.01 mm) thick sheet aluminum. Drill mounting holes in the frames for attaching to the sign panel. Size and space reflectors to provide maximum night legibility and visibility to the finished figure. The Project Manager will conduct a night inspection for legibility and visibility.
3. **Frame Finishing.** Once metal fabrication is complete, de-grease, etch, neutralize, and treat the frame for painting following the paint manufactures recommendation. Paint the frames the specified color

with a quality metal enamel following the paint manufacturer's recommendations. White reflective sheeting meeting Subsection 704.01.10 may be used in place of painting.

4. **Acrylic Plastic Reflector.** Use acrylic plastic reflectors meeting AASHTO M 290 requirements.

C. **Type B Letters—Removable.**

1. **General.** Provide letters, numerals, symbols, and borders that are adhesive-coated reflective sheeting permanently adhered to die cut aluminum backing. De-grease, etch, and treat the aluminum with a light, tight amorphorous chromate type coating. Use Type III white reflective sheeting. Letter and number design is Federal Standard Alphabet Series " E modified ".
2. **Fabrication.** Fabricate letters, numerals, and symbols from minimum 0.040-inch (1.01 mm) thick 3003 H 14 alloy aluminum sheeting. Fabricate borders from 0.032-inch (0.81 mm) thick AA6062 T 6 alloy aluminum sheeting. Prepare the aluminum sheeting and apply the reflective sheeting following the reflective sheeting manufacturer's recommendations. All pieces must have an embossed height of approximately ⅛-inch (3 mm).

   Space mounting holes for screws, bolts, or rivets no more than 8-inches (205 mm) on center; determined by the character size and shape. Edge-seal completed pieces following the reflective sheeting manufacturer's recommendations.

D. **Type C Letters—Direct Applied.**

1. **Sheeting.** Furnish letters, numerals, symbols, and borders from Type III sheeting, permanently adhered to the sign face reflective sheeting.
2. **Fabrication.** Apply the letters, numerals, symbols, and borders following the sheeting manufacturer's recommendations. Follow the size, series, and spacings in the Federal Highway Administration's Standard Alphabets proportion and spacing requirements.

   Assure the finished pieces are clean cut, free of ragged borders.

704.01.12 Paints. Use paints meeting Section 710 requirements.

704.01.13 Hardware. Use bolts, washers, nuts, lock washers, incidental hardware, and angles for erecting aluminum sheet and plywood signs that are:

A. Galvanized meeting ASTM A 153 or ASTM A 164 specifications; or
B. Cadmium-plated steel meeting ASTM A 165; or
C. Aluminum alloy meeting ASTM B 211 for alloy 2024-T4.

704.02 FABRICATION OF SIGNS.

704.02.1 Aluminum Signs. Provide a reflectorized sheet background. Clean rust, white rust, oil, and dirt from the aluminum sheeting. De-grease the sheeting using vapor or alkaline de-greasing agent following the de-greasing agent manufacturer's recommendations. De-grease, acid or alkaline etch, rinse, and dry the sheeting as recommended by the etching solution manufacturer.

Treat the etched sheeting with a light, tight adherent chromate conversion coating before applying the reflective sheeting. This coating must not leave a powdery residue and may leave a silvery iridescence to pale yellow appearance. Coat meeting ASTM B-499, Class 2, 10 to 35 milligrams thick per square foot (0.093 m^2). Hot air dry the sheeting once coated. Apply and seal the reflectorized sheeting on the prepared aluminum sheeting following the reflective sheeting manufacturers recommendations. Meet the applicable requirements of Subsection 704.01.11 for legend and borders.

Color the blind rivet heads to match the sign face. Apply background material to the sheet aluminum before fabricating the sign. Butt the sheet increments together to produce a joint that meets the specified tolerances limits.

Do not use water to float the reflective sheeting or legends into place during fabrication.

704.02.2 Plywood Signs. Provide a reflective background. Seal all wood edges, including interior joints, before fabrication using one coat of exterior aluminum paint followed by one coat of enamel, colored to match the reflective background sheeting. Apply the reflective sheeting and seal the edges following the sheeting manufacturer's recommendations.

A. Screen-Processed Legend and Borders. Screen process or reverse-screen process the legend and borders on reflectorized backgrounds meeting the Contract requirements. Use the process and paints recommended by the sheet manufacturer.

B. Reflective Sheeting Legend and Borders. Cut the legend and borders from Type III sheeting.

Do not splice legend characters. Apply legends following the sheeting manufacturer's recommendations. Do not use water to float the reflective sheeting or legend into place during fabrication.

C. Demountable Reflective Legend and Borders. Fabricate demountable legend meeting Subsection 704.01.11 requirements. Furnish the letter type specified in the Contract. Letters cannot be spliced. Make borders and median sections in the longest pieces possible. Butt all joints with no overlap.

704.02.3 Inspection and Acceptance. Completed signs will be inspected where fabricated for acceptance. Signs will be rejected for defects including, but not limited to cracks, tears, splits, crazing, gouges and curled edges of background sheeting or legends.

SECTION 705
GUARDRAIL AND GUIDE POSTS

705.01 GUARDRAIL. Furnish metal beam and cable guardrail materials meeting the Contract requirements.

705.01.1 Steel Beams and Fittings. Furnish steel beam guardrail meeting AASHTO M 180, Class A, Type 1 requirements. Supply rail in lengths that place the splices on posts. Shape rail to be erected on curve radii less than 150 feet (45.75 m) before erecting.

Use ASTM A 307 bolts with ASTM A 563, Grade A or better nuts. Use ANSI B27.2, Type A plain steel washers.

Galvanize all bolts, nuts, washers, and fittings meeting ASTM A 153 or B 695 (Class 50) requirements.

Furnish rounded end sections, buffer sections, and terminal connectors meeting AASHTO M 180, Class B, Type 1 requirements.

705.01.2 Wood Posts and Blocks. Furnish wood posts and blocks made from Douglas Fir, Hemlock, Ponderosa Pine, Spruce, Larch, or Lodgepole pine. Posts must be straight, sound, free from defects and meet the shapes and dimensions specified in the Contract.

Meet the Western Wood Products Association requirements, or equivalent grading rules, all of which must meet ASTM D 245.

Assure the posts surfaces do not vary more than 1-inch (25 mm) from a straight line connecting the ends. Saw the posts before treating. The posts must be seasoned to accept the specified treatment. Furnish posts and blocks treated with a minimum 5% by weight pentachlorophenol solution or Chromated Copper Arsenate (CCA), type B or C, or Ammoniacal Copper Arsenate (ACA) meeting AWPA standards. The minimum penetration depth is ½-inch (13 mm). Do not paint posts unless specified.

Meet the following strength test: test as a simple beam on a 24-inch (610 mm) span with center loading applied to the post back; it must support at least 30,000 lbs (13,620 kg) before failure.

705.01.3 Concrete Posts. Furnish precast concrete posts meeting the Contract requirements. Use Class "DD" concrete or concrete of equal strength meeting Section 551 requirements. Manufacture, transport, and handle guardrail posts meeting Section 554 requirements. Use reinforcing steel meeting Section 711 requirements.

705.01.4 Lightweight Concrete Guardrail Posts. Lightweight aggregates may be used in manufacturing guardrail posts.

Produce both fine and course aggregates for lightweight concrete by expanding, calcining, or sintering blast furnace slag, clay, diatomite, shale, or slate.

Meet AASHTO M 195 aggregate requirements. Use separate fine and course aggregate. Use fine aggregate in the No.4 (4.75 mm) to 0 size. Use course aggregate of either ¾-inch (19.0 mm) to No.4 (4.75 mm) or ½-inch (12.5 mm) to No. 4 (4.75 mm).

Meet a minimum compressive strength of 3,000 psi (20.7 MPa) (equal to class "DD" concrete) with a maximum absorption of 15% by volume and a maximum unit weight of 115 pounds per cubic foot (1,864 kg per cubic meter). Aggregate pre-wetting may be required.

Use reinforcing steel meeting Section 711 requirements. Steel size and shape is specified in the Contract.

The AASHTO M 195 Freeze-Thaw test is not required.

705.01.5 Steel Posts. Furnish steel posts for cable guardrail meeting the Contract requirements.

705.02. Wire Rope and Connecting Hardware. Furnish wire rope and hardware for cable guardrail meeting the Contract requirements.

705.03. Wood Treatment and Painting.

705.03.1 Wood Treatment. Furnish wood posts and blocks pressure treated meeting Subsection 706.04.1, with a 5 % by weight pentachlorophenol solution Chromated Copper Arsenate (CCA), type B or C, or Ammoniacal Copper Arsenate (ACA) meeting AWPA standards. Chamfer and perform other required framing and boring of bolt holes before post treating. Plug drill holes used for determining preservative penetration depth with tight fitting treated wood plugs. The requirements of Subsection 706.04.2 for incising, do not apply to Ponderosa pine sawn wood posts.

705.03.2 Painting. Use paint and perform painting meeting Subsection 612.03.5 (C)(2) requirements when specified.

705.04 GUIDE POSTS.

705.04.1 Wood Posts. Furnish wood posts meeting Subsection 705.01.2 and 705.03 requirements. Size and shape are specified in the Contract.

705.04.2 Flexible Guideposts. Furnish flexible guideposts meeting the Contract requirements and the following:

The posts must be a white seamless polyethylene extrusion with a minimum 5/32-inch (4 mm) wall thickness having a minimum weight of one pound per foot (1.49 kg/m). The post cross section may be round, triangular, or other shape providing at least 4-inches (100 mm) viewable width.

Erect permanent installations meeting the Contract requirements.

Epoxy-cement or nail temporary installations to the pavement surface.

705.04.3 Hardware. Furnish backplates or faceplates for posts meeting the Contract requirements.

Furnish bolts, nuts, or studs for fastening the backplate to the post, galvanized meeting ASTM A 153 or B 454 (Class 50) requirements or use cadmium plated. Furnish nuts and studs that are "vandal-resistant".

Furnish other miscellaneous hardware galvanized meeting ASTM A 153 or B 454 (Class 50) requirements.

SECTION 706
TREATED AND UNTREATED TIMBER AND TIMBER PILES

706.01 STRUCTURAL TIMBER AND LUMBER. Furnish timbers and lumber being:

A. Standard sawn Douglas fir or Larch.

B. Graded under the current West Coast Lumber Standard Grading Rules or the Western Lumber Grading Rules.

C. Grade stamped by an American Lumber Standards certified inspection agency.

The recommended design values under the rules for grading timbers and lumber grades cannot be less than those shown on the plans for the required minimum timber stress.

Note the grade, the grading rule, and the recommended design stress value for that rule on the shop drawings for each size.

Use only pieces of sound wood free from all decay.

When untreated timber is specified, it must show at least 85% heartwood on the girth, measured where the least amount of heartwood occurs on any girth. When treated timber is specified, there are no heartwood requirements and the sapwood amount is not limited.

706.02 VACANT.

706.03 POLES AND POSTS. Furnish the poles and posts as specified.

706.04 TREATED TIMBER AND LUMBER. Furnish structural timber and lumber, treated with a timber preservative specified as follows.

706.04.1 Treating. Furnish timber and lumber that is pressure treated retaining at least the minimum preservative treatment quantity per cubic foot (cubic meter) specified in AWPA C-14.

Use one of the following preservatives:

Creosote oil, creosote coal tar solution, 5% by weight pentachlorophenol solution, Chromated Copper Arsenate (CCA), type B or C, or Ammoniacal Copper Arsenate (ACA). Use preservative meeting AWPA standards.

Treated timber or lumber to receive paint must permit the paint to adhere to the treated surface without discoloration.

Meet AASHTO M 133 requirements for all preservatives and their sampling and testing methods.

706.04.2 Incising. Mechanically incise timber and lumber of the following listed species having a nominal thickness of 2-inches (actual 38 mm thickness) or greater before treating:

Intermountain Douglas Fir
Pacific Coast Douglas Fir
Western Hemlock
Western Larch
Jack Pine
Lodgepole Pine
Northern White Pine
Red Pine
Sugar Pine
Western White Pine
Red Wood

Incise timber and lumber 3-inches (63 mm actual thickness) thick or greater on all four sides. Incise timber and lumber 3-inches (63 mm actual thickness) thick and less on the wide faces only, unless otherwise specified. The spacing and shape of the cutting teeth and the incising method must produce a uniform penetration. One and a half inch (38 mm actual dimension) center-matched material used for flumes, boxes, etc., do not need to be incised.

The minimum incision depths are as follows:

Size in Inches (mm)	**Minimum Depth of Incision in Inches (mm)**
1½ X 12 (38 X 286 mm)	3/8 (9 mm)
3 X 12 (63 X 290 mm)	7/16 (11 mm)
4 X 12 (89 X 290 mm)	½ (13 mm)
8 X 10 (190 X 240 mm)	9/16 (14 mm)
10 X 12 (240 X 290 mm)	5/8 (16 mm)
12 X 12 (290 X 290 mm)	3/4 (19 mm)

Intermediate size in proportion.

C. Inspection. Each shipment of treated timber or lumber must be inspected before and after treating at the plant by a Department inspector. The inspector must stamp the ends of each accepted piece with the inspector's copyrighted stamp. File a true impression of the copy-righted stamp with the Department before transporting timber or lumber to the project. Provide the Project Manager the inspector's itemized report of all timber and lumber inspected, giving temperatures, quantity of preservative, time of treatment, length and sizes of timbers, total footage, and other pertinent information. Treated timber and lumber not bearing the inspector's stamp in legible form cannot be transported to the project.

Each shipment of untreated timber and lumber must be inspected at its source by a Department inspector. If inspection at the source is, in the Project Manger's opinion impractical the material may be accepted by a " Certificate of Inspection" from a recognized competent grading or inspection bureau or agency.

The acceptance of any material or finished members by the inspector does not prevent their rejection if found defective. Replace rejected material and work at Contractor expense.

706.05 TIMBER PILES. Meet the following straightness requirements for both treated and untreated timber piles.

A straight line from the center of the butt to the center of the tip must lie entirely within the body of the pile. Piles must be free from short crooks that deviate more than 2½-inches (64 mm) from straightness in any 5 foot (1525 mm) length.

A. Treated Timber Piles. Furnish treated timber piling of Douglas Fir, Southern Pine, or Western Larch meeting ASTM D 25 requirements, excluding Tables 1 and 2.

Season, condition, and treat piles meeting ASTM D 1760 and AWPA Standard Specifications for preservative treatment by pressure process. Use creosote oil, creosote coal tar solution, or a 5% by weight pentachlorophenol solution for the preservative.

B. Untreated Timber Piles. Furnish untreated timber piles meeting ASTM D 25 requirements, except for Tables 1 and 2.

SECTION 707
JOINT MATERIALS

707.01 CONCRETE JOINT FILLERS.

707.01.1 Concrete Pavement.

A. **Expansion Joint Filler.** Furnish expansion joint filler type II cork meeting AASHTO M 153 requirements.

B. **Joint Sealing Material.** Furnish sealing material for all types of pavement joints that is a hot-poured thermoplastic rubber or rubber asphalt compound meeting AASHTO M 173, furnished in one grade only. Use ready-mixed, cold applied joint fillers for sealing concrete pavement joints only with the Project Manager's prior written approval.

707.01.2 Concrete Structures Other Than Pavement. Furnish Type II cork pre-formed expansion joint filler meeting AASHTO M 153 requirements.

707.01.3 Concrete Curbs, Gutters, Sidewalks. Use joint material for concrete curbs, gutters, and sidewalks meeting AASHTO M 213 requirements.

707.02 CULVERT SEALERS.

707.02.1 Rubber Gaskets. Furnish ring gaskets meeting AASHTO M 198 requirements.

707.02.2 Flexible Plastic Gaskets. Furnish flexible plastic joint compounds produced from refined hydrocarbon resins and plasticizing materials reinforced with inert mineral filler and not containing solvents. Cohesive and adhesive strength must not be developed by oxidation, evaporation, or chemical action. Supply the gasket in extruded rope form, sized to fill spaces between the pipe sections. Furnish with a two-piece removable wrapper that permits removing one half without disturbing the other half.

Meet the following requirements:

TABLE 707-1

COMPOSITION AND PROPERTIES—FLEXIBLE PLASTIC GASKETS			
		Minimum	**Maximum**
Bitumen (petroleum plastic content)	ASTM D 4	50	70
Mineral Matter (Ash Inert)	AASHTO T 111	30	50
Penetration	ASTM D 217 Cone		
0°C (300 gm) 60 sec		75	—
25°C (150gm) 5 sec		50	120
46.1°C (150 gm) 5 sec		—	150
Softening Point at 25°C Min	ASTM D 36	160°C	—
Specific Gravity at 25°C	ASTM D 71	1.20	1.35
Weight per gallon		10.4	11.25
Ductility at 77(cm) min	ASTM D 113	5.0	—
Flash Point C.o.c., °C	ASTM D 92	315.5	—
Fire Point C.o.c., °C	ASTM D 92	329	—
Volatile Matter	ASTM D 6	—	2.0

707.03 SHEET COPPER, RUBBER, AND PLASTIC WATERSTOPS.

707.03.1 Sheet Copper. Furnish sheet copper for waterstops meeting ASTM B 152 requirements for copper sheet, strip, plate, and rolled bar, type ETP with a nominal weight of 16 ounces per square foot (5 kg per m^2) plus or minus 8%.

707.03.2 Rubber. Furnish molded or extruded rubber waterstops having a uniform cross section, free from porosity or other defects, and meeting the nominal dimensions specified in the Contract. An equivalent standard shape may be furnished if approved. The waterstop may be compounded from natural rubber, synthetic rubber, or a blend of the two, together with other materials that produce a finished waterstop meeting Contract requirements. Reclaimed material cannot be used. Furnish a manufacturer's certificate showing the material composition and the values for the designated properties in Table 707-2. Furnish samples when requested.

TABLE 707-2
PROPERTIES AND TEST METHODS — FINISHED RUBBER WATERSTOP

PROPERTY	FEDERAL TEST METHOD STANDARD NO. 601	REQUIREMENT
Hardness (shore durometer)	3021	60 to 70
Compression set	3311	30% Max.
Tensile strength	4111	2,500 psi Minimum (17 Mpa)
Elongation at breaking	4121	Minimum 450%
Tensile stress @ 300% elongation	4131	Minimum 900 psi (6Mpa)
Water Absorption by weight	6631	Maximum 5%
Tensile strength	7111	Minimum 80% after aging original

707.03.3 Plastic. Furnish plastic waterstops manufactured from virgin polyvinyl chloride plastic or other material meeting Table 707-3 requirements.

TABLE 707-3
PROPERTIES AND TEST METHODS-FINISHED PLASTIC WATERSTOP

ASTM STANDARD	PROPERTY	REQUIREMENT
D 2240	Hardness	75±5
D 412	Tensile Strength, min	2000 psi (14 MPa)
D 412	Ultimate Elongation, min	350%
D 746	Low Temperature	
Procedure B	Brittleness at -37°C	No Failure

Furnish for approval, a drawing or catalog cut of the waterstop intended for use, and a written certificate from the manufacturer that the waterstop meets the specifications.

SECTION 708
CONCRETE, PLASTIC, AND FIBER PIPE

708.01 REINFORCED CONCRETE PIPE.

708.01.1 General. Use cement in reinforced concrete pipe meeting AASHTO M 85 requirements for Portland cement.

Furnish reinforced concrete pipe produced by a manufacturing plant that has been approved by the Engineer before the contract award date.

The bid tabulations will specify only the span dimension to the nearest inch (25 mm), of pipe arch culverts as shown in the Detailed Drawings for the culverts. The plans will show both span and rise dimensions.

The Department will inspect and approve the equipment and methods for manufacturing, protecting, curing and storing pipe before fabrication.

Meet AASHTO M 55 requirements for reinforcement in circular or elliptical pipe.

Use Type V cement when specified.

708.01.2 Circular Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe. Furnish pipe meeting AASHTO M 170 requirements, except that par. 12.4 does not apply. Use a minimum wall B pipe.

708.01.3 Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe. Furnish pipe meeting AASHTO M 206 requirements with Class A-III pipe strength requirements.

708.01.4 Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe. Furnish pipe meeting AASHTO M 207 requirements.

708.01.5 Flared End Terminal Sections and Tee Risers. Furnish flared end terminal sections and the riser of tee sections meeting AASHTO M 170 class III pipe requirements.

708.02. CONCRETE PRESSURE PIPE. Furnish reinforced concrete low head pressure pipe meeting ASTM C 361 requirements.

708.03. PERFORATED CONCRETE PIPE. Furnish perforated concrete pipe meeting AASHTO M 175 requirements.

708.04. POROUS CONCRETE PIPE. Furnish porous concrete pipe meeting AASHTO M 176 requirements.

708.05 PVC GRAVITY SEWER AND DRAIN PIPE.

708.05.1 Pipe. Furnish gravity pipe 4 through 12-inch (105 through 305 mm) nominal diameter produced by continuous extrusion and having self extinguishing characteristics. The PVC plastic must have a cell classification of 12454-B, 12454-C, or 13364-B (minimum tensile modulus of 500,000 psi (34.5 MPa)) as specified in

ASTM D 1784. Meet ASTM D 3034 requirements for pipe and fittings. Meet a minimum Standard Dimension Ratio (SDR) of 35.

Furnish perforated pipe meeting ASTM D 2729 requirements.

Furnish pipe with nominal laying lengths of 12.5 feet (3.8 m), except for connections to manholes, inlets, and other appurtenances.

Assure each pipe length is marked with nominal size, PVC cell classification, SDR, and ASTM designation.

708.05.2 Pipe Joints. Each pipe length must have a bell end. The bell must have an elastomeric rubber gasket in a retaining groove to provide a watertight joint when the pipe is joined. The rubber gasket must maintain a watertight joint under all service conditions including expansion, contraction, settlement, and pipe deformation movements. Make the joint connections following the pipe manufacturer's recommendations.

708.05.3 Appurtenance Joints. Make all connections to manholes, inlets, or other appurtenances watertight using rubber gaskets, waterstops, or non-shrink Portland cement grout for grouted joints.

708.06 PVC PRESSURE WATER PIPE.

708.06.1 Pipe. Furnish pressure PVC water pipe 4 through 12-inch (105 through 305 mm) nominal diameter in either Class 150 with a dimension ratio (DR) of 18 or Class 200 with a dimension ratio (DR) of 14 meeting AWWA Specification C-900. Pipe sections must be marked with diameter, code designation, DR, pressure class, and AWWA specification.

708.06.2 Pipe Joints. Each manufactured length of pipe must have a integral bell with an elastomeric gasket in a retaining groove that provides a watertight joint when joined.

708.07 POLYETHYLENE CORRUGATED DRAINAGE PIPE OR TUBING. Furnish heavy duty corrugated polyethylene drainage pipe or tubing and fittings meeting AASHTO M 252 requirements for nominal diameters 3 through 10-inches (76 through 254 mm) and AASHTO M 294 for nominal diameters 12 through 36-inches (305 through 915 mm).

SECTION 709
METAL PIPE

709.01 DUCTILE IRON AND STEEL WATER PIPE.

709.01.1 Ductile Iron Water Pipe. Furnish ductile iron pipe meeting AWWA C 151 requirements for the pipe class specified in the Contract.

Use mechanical or slip-on joints meeting AWWA C 111 (ANSI A 21.11) requirements. Construct the joints to provide electrical conductivity using bronze shims, or gaskets with metallic shims molded into the gasket.

709.01.2 Steel Water Pipe. Furnish steel pipe meeting AWWA C 200 Standard for Water Pipe, 6-inches (155 mm) and Larger.

Field weld joints and bends meeting AWWA C 206 requirements. Meet AWWA C 203 requirements for shop and field coatings.

709.02 CORRUGATED STEEL PIPE AND PIPE ARCHES. Furnish corrugated steel pipe that is lock seam helically corrugated pipe or continuously welded seam corrugated pipe.

Furnish corrugated steel pipe and pipe arches and coupling bands meeting AASHTO M 36 requirements (excluding projection bands under 9.1.3) and the following:

A. When pipe is cut and to be rejoined, matchmark cut pipe ends and rejoin the matching ends during installation.

B. When using corrugated locking bands, re-roll the pipe ends forming at least two annular corrugations. Unraveling of lock seams due to re-rolling pipe ends is a defect and the pipe will be rejected.

Repair zinc or aluminized pipe coating damaged by re-rolling using a zinc rich paint. Apply the paint to provide a minimum 0.005 inch (0.13 mm) thickness.

If flanges are provided on the pipe ends, the coupling may be made by interlocking the flanges with a preformed channel band or other band incorporating a locking channel that meets AASHTO M 36 requirements. These bands may be used only on pipes with diameters up to and including 36-inches (915 mm).

The coupling bands or devices other than those specified in AASHTO M 36 require the Project Manager's approval before use.

Meet the following additional requirements for syphon and irrigation pipe installations.

1. Use lock seam helically corrugated pipe, or welded seam helically corrugated pipe;
2. Continuously weld lock seams from end to end of each lock seam helically corrugated pipe section for syphon installations. Perform the welding after re-rolling the ends;
3. For irrigation installations using lock seam helically corrugated pipe, weld the lock seams as specified above or fabricate by inserting a 3/16-inch (5 mm) diameter continuous rubber chord meeting pipe industry standards into the lock seam during fabrication, all meeting AASHTO M 36.

Construct watertight field joints. Make the connection using a 10½-inch (267 mm) wide "hugger" type band. Hugger bands must have O-ring

gaskets. Lubricate and install gaskets and coupling bands following the manufacturer's recommendations.

The Project Manager may direct the fabricator to conduct a water-tightness test, witnessed by an inspector, on the type or types of pipe and coupling devices to be furnished. Submit the test method to the Project Manager for approval before testing. Alternate test methods may be required.

709.03 STEEL STRUCTURAL PLATE PIPE AND PIPE ARCHES. Use galvanized corrugated steel structural plates and fasteners for constructing pipe meeting AASHTO M 167 requirements.

Bevel the end plates of structural steel pipe plate arches as specified.

Meet AASHTO M 245 requirements for allowable tolerance in span and rise for pipe arches.

Provide the Project Manager a supplier's itemized statement of the plate sizes for each shipment for field inspection of the plates. Department inspection will include examining pipe for deficiencies in the lengths of sheets used and evidence of poor workmanship. Samples may be taken for chemical analysis and weight of spelter coating.

709.04 BITUMINOUS COATED CORRUGATED STEEL PIPE, PIPE ARCHES, STEEL STRUCTURAL PLATE PIPE AND PIPE ARCHES. Meet AASHTO M 243 pipe coating requirements except as modified below:

Clean and dry the surface to be coated before applying the bituminous coating. Apply coating with the ambient air temperature at least 50 °F (10 °C) and rising. Coat the full circumference of the pipes outside and the bottom up to one third of the vertical height of the pipes inside circumference. Provide a coat thickness of at least 0.05-inch (1.3 mm).

709.05 PRE-COATED, GALVANIZED STEEL CULVERTS AND UNDERDRAINS. Meet AASHTO M 245 and 246 requirements and the requirements of Subsection 709.02 for irrigation and syphon pipe installations.

Provide a minimum 0.010 in (0.25 mm) coating for both inside and outside surfaces meeting AASHTO M 246, Section 7 requirements.

709.06 CORRUGATED STEEL PIPE FOR UNDERDRAINS. Furnish pipe and coupling bands meeting AASHTO M 36 requirements. The class of underdrain in AASHTO M 36 is the Contractor's option.

Furnish semi-circular underdrain and coupling bands meeting AASHTO M 36 requirements and the Detailed Drawings. Furnish nuts, caps, screws and other parts galvanized meeting ASTM A 153 or B 695 (Class 50). Furnish screens and caps for semicircular underdrains meeting the Detailed Drawings.

Furnish bituminous coated underdrains meeting AASHTO M 190 requirements. Nuts, bolts and screens must not be coated.

709.07 CORRUGATED ALUMINUM PIPE AND PIPE ARCH CULVERTS. Furnish corrugated aluminum pipe and pipe arch culverts meeting AASHTO M 196 requirements, and the modifications to AASHTO M 36 specified in Subsection 709.02.

709.08 CORRUGATED ALUMINUM PIPE FOR UNDERDRAINS. Furnish corrugated aluminum pipe for underdrains meeting AASHTO M 196 requirements.

709.09 SEAMLESS STEEL PIPE. Furnish seamless steel pipe meeting ASTM A 53 requirements.

709.10 COPPER PIPE. Furnish copper pipe and tube meeting ASTM B 88, Type K, requirements.

709.11 SLOTTED CORRUGATED STEEL PIPE. Furnish slotted corrugated steel pipe that is commercially fabricated with the grate and steel pipe an integral unit. Pressure or fusion weld the grate spacer bars to the bearing bar. Meet ASTM A 36 requirements for grating materials galvanized after fabrication.

SECTION 710
PAINTS

710.01 PIGMENTS, VEHICLES, AND THINNERS. Assure all materials from which paints are made and formulated meet the following specifications:

(1) Zinc Oxide Pigments ..... ASTM D 79
(2) Pure Chrome Green Pigments ..... ASTM D 212
(3) Iron Blue Pigments ..... ASTM D 261
(4) Calcium Carbonate Pigments ..... ASTM D 1199
(5) Titanium Dioxide Pigments ..... ASTM D 476
(6) Bone Black Pigment ..... ASTM D 210
(7) Carbon Black Pigment ..... ASTM D 561
(8) Black Synthetic Iron Oxide Pigment ..... ASTM D 769
(9) Red and Brown Iron Oxide Pigments ..... ASTM D 3722
(10) Ochre (Ferrous earthy pigments) ..... ASTM D 85
(11) Raw and Burnt Umber Pigments ..... ASTM D 763
(12) Raw and Burnt Sienna Pigments ..... ASTM D 765
(13) Copper Phtalocyanine Blue Pigment ..... ASTM D 963
(14) Iron Blue Pigment ..... ASTM D 261
(15) Ultramarine Blue Pigments ..... ASTM D 262
(16) Chrome Oxide Green Pigment ..... ASTM D 263
(17) Chrome Yellow and Chrome Orange Pigments . ASTM D 211
(18) Yellow Iron Oxide Pigment-Hydrated ..... ASTM D 768
(19) Aluminum Pigments ..... ASTM D 962
(20) Zinc Dust (pigment) ..... ASTM D 520
(21) Magnesium Silicate Pigments ..... ASTM D 605
(22) Diatomaceous Silica Pigments ..... ASTM D 604
(23) Mica Pigment ..... ASTM D 607
(24) Raw Linseed Oil ..... ASTM D 234
(25) Boiled Linseed Oil ..... ASTM D 260
(26) Spirits of Turpentine ..... ASTM D 13
(27) Petroleum Spirits (Mineral Spirits) ..... ASTM D 235
(28) Lampblack Pigments ..... ASTM D 209
(29) Liquid Paint Driers ..... ASTM D 600
(30) Raw Tung Oil ..... ASTM D 12

710.02 PAINTS AND ENAMELS.

A. General. Follow the paint manufacturers recommendations including but not limited to storage, application, thinning, safety precautions, and film thickness unless otherwise specified.

Furnish all paints under this Section free of lead, or zinc chromate unless specified.

Provide the manufacturer's Product Safety Data Sheets. Supply the paint in the original container labeled with the manufacturer's name, address, paint type, formula identification, date of manufacture, and lot or batch number.

Paints for Structural Steel where multiple coats are applied must be produced by the same manufacturer. Provide the Project Manager certified test results from an independent testing facility showing the following paints supplied meet the applicable requirements.

B. Paints for Miscellaneous Metals. Use the following paints on metal unless otherwise specified.

1. **Foliage Green Bridge Paint.** Furnish foliage green paint meeting AASHTO M 67 requirements.
2. **Aluminum Paint, Ready-Mixed**. Furnish aluminum paint meeting AASHTO M 260 (Type II, Leafing Finish).
3. **Aluminum Epoxy Paint.** Furnish aluminum epoxy paint that is a self-priming, two-component, high build, aluminum filled epoxy mastic. The paint must adhere to metal surfaces and existing painted surfaces when the surface is prepared following the paint manufacturer's recommendations.

   Apply the coating following all the manufacturer's recommendations to produce a minimum 5 mil (125 μm) dry film thickness.

   Meet the following minimum paint composition requirements:

Solids	90% ± 2% by volume (ASTM D 2697)
Pigment	19% by volume
Vehicle	66% by volume
Percent non-volatile vehicle	74%
Nominal VOC	0.74 lbs/gal.(89.1 grams/liter)

   The mixed paint must weigh between 11-12 pounds per gallon (1.3 to 1.4 kg per liter) when measured under ASTM D 1475 at 75 plus or minus 2 °F (24 ± 1 °C).

   The mix ratio of the two components must be 1:1 by volume and have a minimum pot life of 4 hours at 75 °F (24 °C) when thinned following the manufacturer's recommendations.
4. **Epoxy paint for pipe pile.** Furnish epoxy paint that is a two-component, self-priming epoxy coating meeting the following requirements:

Drying Time @ 75 °F (24 °C)	
To Touch	2 hrs max.
To Cure	10 days max.
Pot Life @ 70 °F (21 °C)	12 hrs min.
Abrasion Resistance (ASTM D 4060; CS-17 wheel, 1,000 Gram load, 1,000 cycles)	170 mg loss, max.
Direct Impact Resistance (ASTM D 2794)	60 in. lbs. min. (6.8 N·m/min)

   Salt Fog: No blistering, cracking, or film delamination when tested under ASTM B 117 for 1,500 hours.

   Moisture Condensation Resistance: No blistering, cracking, or film delamination when tested under ASTM D 2247 for 1,000 hours.

5. **Equipment Enamel.** Furnish equipment enamel that is formulated using Federal Specification TT-E-489b, class A, spray or brush consistency as specified in the Contract. Match the appropriate color chip, available from the Materials Bureau. Meet the thinner requirements of Federal Specification TT-T306. Use at a maximum rate of 1 pint per gallon (0.12 L per L) when required.
6. **White, Yellow, and Black Enamel.** Furnish water resistant enamels made from synthetic gums capable of brush application to vertical metal surfaces without running, streaking, or sagging. Meet the following requirements:

	White	Yellow	Black
Coarse particles and skins retained on No.325 sieve, max (45 μm)	0.50%	0.50%	0.50%
Nonvolatile matter, min	85%	85%	85%
Dry to touch at 70°F (21°C) time in hours, Max.	5	5	5
Dry hard at 70°F (21°C) time in hours, Max.	24	24	24
Toughness, Kauri reduction test at 75°F (24°C), min.	150%	150%	150%
Hiding power, square feet per gallon (m^2 per L) by Pfund cryptometer Model E, Black plates, min.	300 (7.3)	450 (11)	

Meet Federal Test Method Standard No. 141C for whitening, dulling, or change in color; brushing, flowing, covering, and leveling properties.

The white enamel must be equal in brightness to Rutile (Type IV) Titanium Dioxide Pigment.

Yellow enamel must match standard color sample for D-2 yellow guardrail paint. Black enamel must be jet black and cover completely in one coat.

7. **Zinc Phosphate Paint.** Zinc Phosphate Paint may be used as a primer or finish coat unless otherwise specified. Provide the finish paint color specified in the Contract and match the appropriate color chip, available upon request. The paint must:
   a. Be well-ground;
   b. Show no skinning in a freshly opened, full can;
   c. Not cake or settle in the container;
   d. Readily break up with a paddle to a smooth, uniform consistency;
   e. Brush easily, possess good leveling qualities;
   f. Dry to a hard uniform finish.

   The paint composition must meet the following requirements:

	Min.	Max.
Pigment[4]	56.5%	58.5%
Vehicle[5]	41.5%	43.5%

	Min.	Max.
Pigment Composition:		
Zinc Phosphate	60.0%	—
Titanium Dioxide[6] (Rutile)	13.0%	—
Calcium Carbonate	21.4%	—
Vehicle Composition:		
Alkyd Phthalic Resin (50% Solids)	52.4%	—
Raw Linseed Oil	26.2%	—
Mineral Spirits	17.2%	—
Driers and Additives	4.2%	—
Finished Paint:		
Consistency (Krebs-Stormer)[1]	70KU	83KU
Weight Per Gallon[2]	(5.7 kg) 12.6 lbs.	—
Dry To Touch[3]	—	8 Hrs.
Dry To Handle[3]	—	16 Hrs.
Dry Film Thickness	1.0 mil	—

[1]By ASTM D-562, [2]By ASTM D-1475, [3]Federal Test Method Standards 141C Method 4061.2, [4]Federal Test Method No. 141-Method 4021, [5]Federal Test Method No. 141-Method 4051, [6]ASTM D 1394

710.02.3 Paint Coating Systems for Structures.

A. Epoxy Zinc Rich Primer. Meet AASHTO M 300 type I or II requirements excluding those in section 4.7.

B. Intermediate Coat. Use a two-component polyamide epoxy meeting the following requirements:

Drying Time @ 50 °F (10° C)
To Touch ..... 4 hrs max.
Tack Free ..... 24 hrs max.
Cure ..... 14 Days max.

Pot Life @ 50° (10 °C) ..... 10 hrs min.
Abrasion Resistance ..... 224 mg max. loss
(ASTM D 4060, CS-17 wheel, 1,000 cycles)
Direct Impact Resistance ..... 120 in. lbs.
(13.6 N·m min.)

Salt Fog: No blistering, softening, cracking or film delamination when tested under ASTM B 117 for 1,000 hours.
Moisture Condensation Resistance: No blistering, rusting or delamination when tested under ASTM D 2247 for 1,000 hrs. at 100 °F (37 °C).

C. Finish Coat. Provide a two component finish epoxy meeting the following requirements:

Drying Time @ 50 °F (10 °C)
To Touch ..... 10 hrs. max.
Tack Free ..... 24 hrs. max.
Cure ..... 14 Days max.

Pot Life @ 50 °F (10 °C) ..... 10 hrs. min.
Abrasion Resistance ..... 224 mg. max. loss
(ASTM D 4060, CS-17 wheel, 1,000 cycles)
Impact Resistance ..... 120 in. lbs.
(6714 mm kg min.)

Salt Fog: No blistering, softening, cracking or film delamination when tested under ASTM B 117 for 1,000 hours.
Moisture Condensation Resistance: No blistering, rusting or delamination when tested under ASTM D 2247 for 1,000 hours at 100 °F (37 °C).

SECTION 711
REINFORCING STEEL, STRUCTURAL STEEL HARDWARE, AND MISCELLANEOUS STRUCTURE ITEMS

711.01 REINFORCING STEEL.

711.01.1 Bar Reinforcing. Furnish the specified reinforcing steel meeting AASHTO M 31 requirements.

The Project Manager may accept small lots of reinforcing steel subject to it passing the bending test specified in AASHTO M 31.

711.01.2 Epoxy-Coated Reinforcing Bars. Furnish epoxy-coated reinforcing bars meeting AASHTO M 284 and the Contract requirements.

711.01.3 Wire and Wire Mesh. Furnish concrete reinforcing wire meeting AASHTO M 32 requirements.

Furnish wire mesh reinforcing for concrete meeting AASHTO M 55 requirements and the Contract.

Furnish bar mats meeting AASHTO M 54 requirements.

711.02 STRUCTURAL STEEL. Furnish structural steel for:

- **A.** Bridge superstructure applications meeting AASHTO M 270/ M 270M for Temperature Zone 3;
- **B.** Other applications meeting AASHTO M 183/ M 183M.

711.03 STRUCTURAL STEEL TUBING. Furnish structural steel tubing for bridges meeting ASTM A 500, Grade B, requirements for cold-formed welded seamless carbon steel structural tubing in rounds and shapes.

711.04 PINS AND ROLLERS. Furnish pins and rollers of annealed carbon steel forging's meeting AASHTO M 102, Class C requirements, or cold-finished carbon steel shaft meeting AASHTO M 169 requirements, Grades 1018 to 1030 inclusive. Fabricate pins and recessed pin nuts as detailed in the AISC Manual of Steel Construction, current edition.

711.05 WELDING ELECTRODES. Use welding electrodes meeting AWS, AASHTO and the Contract requirements.

711.06 HIGH TENSILE STRENGTH BOLTS. Furnish heat-treated carbon steel bolt, nut, and washer material meeting AASHTO M 164 requirements.

Specify in the purchase order for galvanized high tensile strength bolts that copies of the manufacturer's inspection test reports for the materials be forwarded with the order. Make the reports available to the Project Manager upon request.

Rockwell C hardness cannot exceed 32 before galvanizing.

711.07 BOLTS AND NUTS. Furnish bolts, threaded rod, and nuts meeting ASTM A 307 Grade A requirements. Use hexagonal headed nuts for steel machine bolts and tap bolts.

711.08 GALVANIZED METAL. Furnish galvanized ferrous metal products meeting AASHTO M 111 requirements, or when applicable, meeting ASTM B 695 (Class 50) requirements.

711.09 WELDED STUD SHEAR CONNECTORS. Furnish shear connector studs meeting the AWS specification for "Stud Welding" and the Contract requirements.

711.10 STEEL PILING.

711.10.1 Structural Steel Piles. Furnish structural steel piles meeting ASTM A 36 and the Contract requirements. Bent or damaged piles will be rejected.

711.10.2 Steel Pipe Piles. Furnish new steel pipe piles meeting ASTM A 252, Grade 2 requirements. Steel pipe diameter and wall thickness is specified in the contract.

Use closure plates for closed-end piles meeting AASHTO M 183 requirements. The pipe, including end closures, must be capable of being driven by the specified methods without distortion. Closure plates and connecting welds must not project beyond the perimeter of the pile tips.

711.11 PRESTRESSING STEEL. Furnish prestressing steel meeting ASTM A 416 requirements.

711.12 CASTINGS.

711.12.1 Steel Castings for Highway Bridges. Furnish castings meeting AASHTO M 192, class 485 requirements.

711.12.2 Chromium Alloy Steel Castings. Furnish castings made from grade CA-15 meeting AASHTO M 163 requirements.

711.12.3 Drainage Structure Castings. Furnish structural drainage castings meeting the Detailed Drawing requirements and AASHTO M 306 requirements modified as follows:

1. References to Federal Specification RR-F-621C is changed to read RR-F-621 and current amendments thereto;
2. The Grey iron casting requirements of Subsection 3.1 are changed to AASHTO M 105 (ASTM A 48) Class 207;
3. The weight requirement of Subsection 4.2.4 is (plus or minus 5% Drawing/Specification Weight);
4. The proof load testing of Subsections 7.1 and 9.1.1 is 25,000 lbs. (110 kN);
5. Delete Subsections 11.1.2 and 11.1.3;
6. Subsection 11.1.4 is changed to read Heat number or date.

711.13 BEARING ASSEMBLY ANCHOR BOLTS FOR BRIDGES. Furnish anchor bolts sized as specified and meeting ASTM A 36 requirements.

711.14 ELASTOMERIC BEARING DEVICES. Furnish elastomeric bearings meeting AASHTO M 251 and the Contract requirements.

711.15 COMPRESSION JOINT SEALS. Furnish preformed elastic joint seals meeting the open cell compression seal requirements of ASTM D 3542 and the Contract.

Furnish joint seals that accommodate the design movement specified in the contract and follow the manufacturers recommended installation width.

Use the seal manufacturer's recommended adhesive lubricant for seal installation. Use Lubricant meeting ASTM D 4070 requirements.

Provide the Project Manager a minimum 3 foot (915 mm) long seal sample taken from each size and type furnished on the project. Order the seals 3 feet (915 mm) longer than required for the installation. Furnish the Project Manager, two copies of the manufacturers certificate of compliance meeting Subsection 106.03, attesting that the material meets specifications.

Obtain the Project Manager's approval of all joint seals before installation.

Install the seals following the manufacturer's recommendations. Do not field splice seals.

Furnish and install the seals, including these costs in the bid price for structural steel.

711.16 FIBER REINFORCED PADS. Furnish pads made from new un-vulcanized rubber and synthetic fibers. Each component must make up 50% of the pads weight.

The pad surface must have:

1. A standard rubber hardness of 80 plus or minus 5 Shore A durometer;
2. An ultimate compressive breakdown strength of at least 7,000 psi (48.3 MPa);
3. A minimum and maximum pad thickness of 1/16-inch (2 mm) and 1/8-inch (3 mm), respectively.

Furnish the manufacturer's certification to the Project Manager that the pads meet these specifications. Assure a copy of the certification accompanies the shipment to the project. Pads not meeting these requirements will be rejected.

Fiber reinforced pads are incidental to and included in payment for other structural steel work.

711.17 METAL BIN-TYPE RETAINING WALLS. Furnish Metal bin-type retaining walls meeting the Contract requirements.

Furnish the necessary bolts and appurtenances for complete assembly of the members into a continuous closed-face wall of connected bins.

Assure the base metal and spelter coating meet AASHTO M 218 requirements.

Use galvanized bolts, nuts, washers, and other hardware meeting ASTM A 153 or B 695 (Class 50, Type I) requirements.

Assure all members are fabricated so units of the same nominal size are fully interchangeable. Do not drill, punch, or drift holes to correct defects in manufacture. Replace members having improperly punched holes at Contractor expense.

Remove and replace damaged members or members with damaged or broken spelter at Contractor expense.

Meet the applicable treatment and handling requirements for bituminous-coated steel structural plate pipe and pipe arches under Section 709 when handling bituminous-treated walls. Repair broken or damaged bituminous coating at Contractor expense.

SECTION 712
FENCING MATERIALS

712.01 CHAIN LINK FENCE.

712.01.1 General. Meet AASHTO M 181 requirements, as modified herein. Use one of the following fence fabrics, as specified in the Contract:

- Type 1 Class C Zinc-Coated Steel,
- Type 2 Aluminum-Coated Steel,
- Type 3 Aluminum Alloy,
- Type 4 Vinyl-Coated Fabric.

Use zinc-coated steel for all Type 1 or Type 2 fabric fence posts, rails, gate frames, expansion sleeves, wire ties, fabric ties, hog rings, tension wire, miscellaneous fittings, and hardware. Use aluminum alloy for these same Type 3 fabric fence parts. Use either zinc-coated steel or aluminum alloy for these Type 4 fabric fence parts.

712.01.2 Fence Fabric. Furnish fence fabric having 2-inch (50 mm) openings and meeting AASHTO M 181 requirements. Use 11-gauge wire for fabric 48-inches (1,220 mm) high and under. Use 9-gauge wire for fabric 60-inches (1,525 mm) high and over. The fabric height is specified in the contract.

712.01.3 Posts, Rails, and Braces. Meet Table 701-1 and the Contract length requirements. Furnish all posts with a watertight cap that fits securely over the outside post top and supports the top rail.

712.01.4 Truss Rods. Furnish ⅜-inch (9.5 mm) truss rods as follows:

- steel - galvanized with drop-forged turnbuckles or other approved type of adjustment.
- aluminum - with cast aluminum turnbuckles or other approved type of adjustment.

712.01.5 Fabric Bands and Stretcher Bars. Furnish bands as follows:

- steel - a minimum ⅛-inch (3 mm) thick by ¾-inch (19 mm) wide
- aluminum - a minimum ⅛-inch (3 mm) thick by ⅞-inch (22 mm) wide.

Furnish aluminum or steel stretcher bars as follows:

- a minimum ¼-inch (6 mm) thick by ¾-inch (19 mm) wide
- at least 2-inches (50 mm) shorter than the fabric width used.

712.01.6 Tie Wire. Furnish 9-gauge galvanized steel tie wire meeting ASTM A 116 requirements. Furnish 11-gauge, Class 1 galvanized steel hog ring fasteners meeting ASTM A 116 requirements.

Furnish 9-gauge aluminum tie wire meeting ASTM B 211 Alloy 1100, Temper H14 requirements. Furnish minimum 11-gauge aluminum hog ring fasteners meeting ASTM B 211, Alloy 6061 requirements.

712.01.7 Tension Wire. Furnish 7-gauge galvanized coiled spring steel tension wire. Meet ASTM A 116, Class 1 galvanizing requirements.

Furnish 6-gauge aluminum tension wire meeting ASTM B 211, Alloy 6061, Temper T 94 requirements.

712.01.8 Gates. Furnish gates complete with all necessary hinges, latch, and drop-bar locking device for the type of gate and gate posts specified. Meet AASHTO, AWS specifications, and the contract requirements for all welding.

A. Steel Gates. Construct gate frames from steel sections meeting Table 712-1 requirements. The gate frame corners may be welded or fastened and reinforced with galvanized malleable-iron fittings designed for this use.

Use chain link fabric for gate frames meeting Subsection 712.01.2 and match the fabric used in the fence.

B. Aluminum Gates. Construct gate frames from aluminum sections meeting Table 712-1 requirements. Assemble the gates frames by welding.

Use aluminum alloy cast hinges meeting ASTM B 108 or B 26 requirements or made of malleable iron or steel and hot-dip galvanized or mechanically galvanized meeting ASTM B 695 (Class 50). Make all latches, stops, and keepers of the aluminum alloy specified for hinges or use galvanized malleable iron or pressed steel.

Use chain link fabric for the gate frame meeting Subsection 712.01.2 requirements and matching the fabric used in the fence.

TABLE 712-1
TABLE OF FENCE SUPPORTS & FRAMING FOR CHAIN LINK FENCE

USE		STEEL-SHAPE, SIZE, WEIGHT	ALUMINUM-SHAPE, SIZE, WEIGHT
Line Posts	Grade 1	1.90" O.D. Pipe @ 2.70 lb/ft (48 mm O.D. Pipe @ 4 kg/meter) 1.875' x 1.625' x 0.113' H-Section @ 2.70 lb/ft (571 mm x 495 mm x 35 mm @ 4 kg/meter)	2.375" O.D. Pipe @ 1.25 lb/ft (61 mm O.D. Pipe @ 1.85 kg/meter) 2.25" x 1.95" H-Section @ 1.25 lb/ft (58 mm x 50 mm H-Section @ 1.90 kg/meter)
	Grade 2	1.90" O.D. Pipe @ 2.28 lb/ft (48 mm O.D. Pipe @ 3.40 kg/meter)	
End, Corner & Pull Posts	Grade 1	2.375" O.D. Pipe @ 3.65 lb/ft (61 mm O.D. Pipe @ 5.40 kg/meter) 2.0" x 2.0" sq. Tubing @ 3.61 lb/ft (51 mm x 51 mm sq. tubing @ 5.40 kg/meter)	2.875" O.D. Pipe @ 2.0 lb/ft (75 mm O.D. Pipe @ 3 kg/meter) 3.0" x 3.0" sq. Tubing @ 2.0 lb/ft (76 x 76 mm sq. Tubing @ 3 kg/m)
	Grade 2	2.375" O.D. Pipe @ 3.12 lb/ft (61 mm O.D. Pipe @ 4.6 kg/meter)	
Gate Posts Gate Leaf Width 6 ft and less (1.8 m and less)	Grade 1	2.875" O.D. Pipe @ 5.79 lb/ft (73 mm O.D. Pipe @ 8.60 kg/meter) 2.5" x 2.5" sq. Tubing @ 5.7 lb/ft (64 mm x 64 mm Tubing @ 8.50 kg/meter)	2.875" O.D. Pipe @ 2.0 lb/ft (73 mm O.D. Pipe @ 3 kg/meter)
	Grade 2	2.875" O.D. Pipe @ 4.64 lb/ft (73 mm O.D. Pipe @ 6.9 kg/meter)	3.0" x 3.0" sq. Tubing @ 2.0 lb/ft (76 x 76 mm sq. Tubing @ 3 kg/meter)
Over 6 ft thru 13 ft (1.8 thru 4 m)	Grade 1	4.0" O.D. Pipe @ 9.10 lb/ft (105 mm O.D. Pipe @ 13.5 kg/meter) 3.0" x 3.0" sq. Tubing @ 9.10 lb/ft (76 mm x 76 mm Tubing 13.5 kg/meter)	4.0" O.D. Pipe @ 3.0 lb/ft (102 mm O.D Pipe @ 4.50 kg/meter)
Over 13 ft thru 18 ft (4 thru 5.5 m)	Grade 1	6.625" O.D. Pipe @ 18.97 lb/ft (168 mm O.D. Pipe @ 28.20 kg/meter)	6.625" O.D. Pipe @ 7.0 lb/ft (168 mm O.D. Pipe @ 10.50 kg/meter)
Rails and Braces	Grade 1	1.660" O.D. Pipe @ 2.27 lb/ft (42 mm O.D. Pipe @ 3.40 kg/meter)	1.660" O.D. Pipe @ 0.786 lb/ft (42 mm O.D. Pipe @ 1.2 kg/meter)
	Grade 2	1.660" O.D. Pipe @ 1.84 lb/ft (42 mm O.D. Pipe @ 2.70 kg/meter)	
Gate Frames Leaf Width Less than 8 ft. (2.4 m)	Grade 1	1.660" O.D. Pipe @ 2.27 lb/ft (42 mm O.D. Pipe @ 3.40 kg/meter) 1.5" x 1.5" sq. Tubing @ 1.90 lb/ft (38 mm X 38 mm Tubing @ 2.90 kg/meter)	1.900" O.D. Pipe @ 0.94 lb/ft (48 mm O.D. Pipe @ 1.40 kg/meter) 2.0" x 2.0" sq. Tubing @ 0.94 lb/ft (51 x 51 mm sq. Tubing @ 1.40 kg/meter)
	Grade 2	1.660" O.D. Pipe @ 1.84 lb/ft (42 mm O.D. Pipe @ 2.70 kg/meter)	
Over 8 ft (2.4 m)	Grade 1	1.90" O.D. Pipe @ 2.72 lb/ft (48 mm O.D. Pipe @ 4 kg/meter) 2.0" x 2.0" sq. Tubing @ 2.10 lb/ft (51 mm x 51 mm sq. Tubing @ 3.10 kg/meter)	1.90" O.D. Pipe @ 0.94 lb/ft (48 mm O.D. Pipe @ 1.40 kg/meter) 2.0" x 2.0" sq. Tubing @ 0.94 lb/ft (51 x 51 mm sq. Tubing @ 1.40 kg/meter)
	Grade 2	1.90" O.D. Pipe @ 2.28 lb/ft (48 mm O.D. Pipe @ 3.40 kg/meter)	

712.02 INTERSTATE FENCE AND FARM FENCE.

712.02.1 Woven Wire. Furnish woven wire meeting ASTM A 116 requirements and the following:

A. Interstate Wire Fence. Use woven wire that is No. 12½ Grade 60, Design Number 832-6-12½, shown in Table 1 of ASTM A 116. Zinc coating must be Class 1 shown in Table 3 (ASTM A 116).

B. Farm Fence. Use woven wire that is No. 12½ Grade 60 in ASTM A 116, Table 1. Provide a stay wire spacing of 6-inches (155 mm). Match the fence height and mesh dimensions of the fence being replaced if not specified. Zinc coating must be Class 1 as shown in Table 3 (ASTM A 116).

712.02.2 Barbed Wire. Use 2-point 12½ or 13½ gauge barb wire meeting ASTM A 121 requirements. Space barbs a nominal 4-inches (105 mm) or a nominal 5-inches (130 mm). Zinc coating must be Class 1 for 12½ and 13½ gauge wire. Provide the Project Manager Certification that the wire meets ASTM A 121 requirements.

712.02.3 Brace Wire. Use 9 or 12½ gauge soft, smooth wire.

712.02.4 Staples and Nails. Use minimum 9-gauge U-shaped, 1¾-inch (45 mm) long staples unless otherwise specified.

712.02.5 Tie Wires. Use minimum 12½ gauge galvanized tie wire. Commercial galvanized fasteners supplied with the wire may be used if approved by the Project Manager.

712.02.6 Metal Fence Stays. Use commercially made and fabricated metal fence stays from 9½ gauge wire twisted to form a two wire unit.

712.02.7 Metal Posts and Assemblies. Provide metal fence posts and assemblies meeting ASTM A 702 requirements, modified as follows: Tables 3, 4, and 6.1 through 6.2.2 of ASTM A 702 apply to finished posts and assemblies after fabrication, punching, drilling, and finish coating.

Galvanize or paint posts, braces, and anchor plates. Meet AASHTO M 111 galvanizing requirements. Furnish nuts, bolts, fittings, and other hardware meeting ASTM A 153 or B 695 (Class 50) galvanizing requirements. Paint following the paint manufacturer's recommendations.

Furnish fence posts and braces of the lengths in Table 712-2.

TABLE 712-2
POST LENGTHS

Fence	Post Type	Corner, End Gate, Pull & Panel Posts	Line Posts	Brace and Brace Rail
Interstate	Metal	7'-8" (2.3 m)	6'-6" (2.0 m)	7'-8" (2.3 m)
Interstate	Wood	8'-0" (2.4 m)	7'-0" (2.1 m)	8'-0" (2.4 m)
Farm	Metal	7'-0" (2.1 m)	6'-6" (2.0 m)	7'-8" (2.3 m)
Farm	Wood	8'-0" (2.4 m)	7'-0" (2.1 m)	8'-0" (2.4 m)

Use 2½" X 2½" X ¼" (64 X 64 X 6 mm) or heavier metal fence posts for Interstate and Farm fence for corner, end, gate and pull posts. Use 2" X 2" X ¼" (51 X 51 X 6 mm) or heavier metal pipe brace posts. Line posts must have a nominal weight of 1.33 lbs. per foot (2 kg per meter) (exclusive of anchor plates).

The metal must be a good commercial-quality steel having a maximum 0.82 percent carbon content.

Use Tee, Channel, U, or Y bar section line posts with corrugations, knobs, notches, holes, or studs placed to engage the fence line wires.

Weld a steel anchor plate to each line post so that the anchor top is 2 to 3-inches (50 to 75 mm) below groundline when the post is set to the specified depth.

712.02.8 Wood Fence Posts and Brace Rails.

A. General. Make posts and brace rails from well-seasoned, sound, and straight-grained Western Larch, Lodgepole Pine, Ponderosa Pine, or Douglas Fir. Remove all bark from the posts.

Taper round posts to be driven for 8 to 12-inches (205 to 305 mm) up from the bottom to a 1-inch (25 mm) point. Taper the post tops to a round top with a minimum 3-inch (75 mm) diameter for line posts and 4-inches (105 mm) for corner, brace, pull, end, and gate posts. These taper lengths are included in the specified post lengths. Perform all tapering before treatment.

Brace rails for farm fence do not require treatment. Use minimum 4-inch (105 mm) diameter brace rails. All posts with a bow exceeding 2-inches (50 mm) in 7 feet (2.1 m) will be rejected.

B. Posts for Farm Fence. Furnish posts meeting the dimensional requirements in Subsection 712.02.8 (C).

Treat the posts with a minimum 5 percent by weight pentachlorophenol solution or Chromated Copper Arsenate (CCA), Type B or C, or Ammoniacal Copper Arsenate (ACA) meeting AWPA Standards. Assure the treatment penetrates the wood at least ½-inch (13 mm) or full sap, with a minimum retention of 0.4 lbs. per cubic foot (6.50 kg per cubic meter).

Extend the treatment for at least 36-inches (915 mm) for line posts and 48-inches (1,220 mm) for all other posts. Post treatment must be at a Department approved plant.

C. Posts For Interstate Fence. Furnish line posts and brace rails from a minimum 4-inch (105 mm) diameter, naturally round, or a minimum 4 X 4-inch (105 X 105 mm) square sawn. Furnish corner, end, gate, pull, and brace posts from a minimum 5-inch (130 mm) diameter naturally round post or a 5 X 5-inch (130 X 130 mm) square sawn post.

Treat all wood fence material meeting Subsection 706.04.1 requirements.

712.02.9 Metal Gates. Furnish each gate complete with hinges, latch, and all other hardware used with the type of gate and gate post specified.

712.02.10 Gates For Interstate Fence. Use plain-top single-drive metal gates of tubular steel frame with wire fabric filler. Fit the gate to the opening between the gate posts of the approximate widths shown in the Detailed Drawings. Provide a centered steel upright brace for gates for openings of less than 14 feet (4.3 m), two upright steel braces at third points for gates for openings of 14 feet (4.3 m) or greater.

Fill the metal gates with galvanized wire fabric securely fastened to the top, bottom, ends of the gate frame.

Use fabric meeting Subsection 712.02.1, class 1 or better.

The approximate weight of the gate frames (less fabric) must be as follows:

Width of Opening	Approximate Weight *
8'(2.4 m)	48 pounds (22 kg)
10' (3 m)	55 pounds (25 kg)
12'(3.7 m)	62 pounds (28 kg)
14'(4.3 m)	72 pounds (33 kg)
16'(4.9 m)	80 pounds (36 kg)

*Heavier gates will be permitted if they meet all other requirements

712.02.11 Gates For Farm Fence. Furnish farm fence gates meeting the Detailed Drawings and Contract requirements.

712.02.12 Deadman or Anchor.

Furnish deadman and anchor(s) meeting the Detailed Drawing requirements.

712.02.13 Miscellaneous. Bolts, nuts, fittings, hinges, and all other metal parts for constructing fences and gates must be galvanized meeting the specified ASTM specification.

SECTION 713
MISCELLANEOUS MATERIALS

713.01 WATER. Furnish water for mixing and curing concrete that meets AASHTO M 157, 4.1.4 requirements. Water will be tested under AASHTO T 26. Known potable water may be used without testing.

Use irrigation quality water for irrigating trees, plants, and seeded areas, free of elements harmful to plant growth.

713.02 HYDRATED LIME. Furnish hydrated lime meeting AASHTO M 303 requirements. Use Type II lime or use Type I in increased quantity to provide the required total calcium and magnesium oxides.

713.03 CALCIUM CHLORIDE. Furnish calcium chloride meeting AASHTO M 144 requirements.

713.04 CEMENT GROUT. Produce grout consisting of 1 part portland cement to 3 parts of sand thoroughly mixed with water to produce a uniform thick mortar. Use mortar within 30 minutes of adding water. Mortar cannot be re-tempered.

Use sand for mortar meeting Subsection 701.01.1 and Table 713-1 gradation requirements.

TABLE 713-1

MORTAR SAND GRADATION REQUIREMENTS	
Passing a No.4 Sieve (4.75 mm)	100%
Passing a No.8 Sieve (2.36 mm)	90-100%
Passing a No.16 Sieve (1.18 mm)	60-90%
Passing a No.50 Sieve (0.300 mm)	15-40%
Passing a No.100 Sieve (0.150 mm)	0-10%

713.05 TOPSOIL. Furnish topsoil meeting Table 713-2 gradation requirements.

TABLE 713-2
TOPSOIL GRADATION REQUIREMENTS

FRACTION	PARTICLE SIZE (mm)	MAX. % OF SOIL (-10 MESH) (2MM) FRACTION
Sand	0.05 - 2.0	85
Silt	0.005 - 0.05	80
Clay	Less than 0.005	50
Gravel	Larger than 2.0	* Max. % of Total Sample

* A maximum of 20% is allowable. Any quantity exceeding 10% is not included in the basis for payment. Gradation is tested under AASHTO T 88.

Meet the following:
1. Soil pH between 5.5 and 8.0 or up to 8.5 if the exchangeable sodium is less than 10 percent;
2. Soil conductivity factor less than 4;
3. Organic content between 1% to 20%.

Topsoil is sampled and tested under Montana Test Method MT-412.

713.06 MINERAL FILLER. Mineral filler is portland cement, ground limestone dust, fly ash, or graded fines free of silt or clay produced from crushing stone, gravel, slag, or other non-plastic mineral matter. Mineral filler and their sources are subject to the Project Manager's approval.

Furnish mineral filler meeting Table 713-3 gradation requirements when tested under MT-301.

TABLE 713-3
MINERAL FILLER GRADATIONS

SIEVES	TOTAL PERCENT PASSING
No. 30 (0.600 mm)	98-100%
No. 80 (0.180 mm)	95-100%
No. 200 (0.075 mm)	65-100%

Meet the following:
1. Dry and free from fine particle lumps;
2. Free carbon less than or equal to 5% by weight as measured by the loss on ignition test;
3. Silica content less than or equal to 10% for un-calcined materials.

AASHTO T 165, T 167, and Montana Test Method MT-306 or other tests may be used to determine the need for mineral fillers.

713.07 CONCRETE CURING AND PROTECTIVE COATINGS.

713.07.1 Water-Soluble or Emulsified Liquid Membrane-Forming Linseed Oil Compounds. Furnish water-soluble or emulsified liquid membrane-forming linseed oil compounds meeting AASHTO M 148 requirements. Linseed oil compounds, when used as a protective coat must contain a minimum 2.7 pounds (0.32 kg) of linseed oil per gallon (liter).

Furnish a manufacturers written certification to the Project Manager showing the formulated weight of linseed oil per gallon (liter) meets or exceeds this limit.

713.07.2 Miscellaneous Combination Curing and Protective Coating Compounds. Obtain the Project Manager's written approval before using a commercial product.

Meet AASHTO M 148 requirements for a liquid membrane-forming compound for curing concrete.

713.07.3 Membrane Curing Compounds. Use membrane curing compounds meeting AASHTO M 148 requirements.

713.08 SEED.

713.08.1 Grass Seed. Furnish all seed that meets and is labeled under Montana Seed Law and meeting the Contract requirements.

Furnish seed originating from the North American Continent above 41 degrees latitude. Make written request for waivers of the above requirements to the Department Agronomist.

Furnish seed free of prohibited noxious weed seed with restricted weed seed not exceeding Montana Seed Law.

Wet, moldy, or otherwise damaged seed will be rejected.

Calculations of " pure live seed" may be made based on either a germination test or a tetrazolium test, in addition to the purity analysis.

Furnish the Project Manager a purity analysis and germination test of the seed proposed for use. A germination test must have been performed within 12 months of the seeding date.

Apply seed on a "pure live seed" basis. The quantity of "pure live seed" per 100 pounds (45.4 kg) of seed is determined as follows:

% "Pure live seed" = Germination % X Purity X 100
Bulk Seed needed = Total lbs. pure live seed required ÷ % Pure live seed X 100

Notify the Project Manager in writing of the seed source and the approximate date the seeding will begin. Submit the notification at least 6 weeks before seeding begins. Do not begin seeding until the germination and purity test results are known.

Make each species of seed available in separate bags for sampling and inspection.

713.08.2 Legume Seed. Meet Subsection 713.08.1 requirements for source, grade, purity, germination, and "live seed" definition. Use the inoculant's specified in the Contract when seeding legumes.

713.09 FERTILIZER. Use commercially manufactured fertilizer meeting the Contract requirements.

The fertilizer must be labeled with the manufacturer's guaranteed analysis, meeting Montana fertilizer laws.

Contaminated or damaged fertilizer will be rejected.

Apply fertilizer at the rate specified in the Contract.

713.10 MULCH.

713.10.1 Vegetative Mulch. Vegetative mulch is pliable cereal grain straw or grass hay at least 8-inches (205 mm) in length.

Mulch will be rejected for the following reasons:

1. Chopped or ground mulch;
2. Mulch that is musty, moldy, rotted, or contains noxious weed or grass seed-bearing stalks;
3. Mulch containing stones, dirt, roots, stumps, and other foreign material.

713.10.2 VACANT.

713.10.3 Fabricated Netting. Fabricated netting is composed of burlap, kraft paper string, or similar products and may be fabricated on the project.

Submit samples for testing and approval before use.

713.10.4 Wood Cellulose Fiber Mulch. Wood cellulose fiber mulch is specially prepared wood cellulose fibers free of growth or germination inhibiting materials that forms a homogeneous slurry when combined with water, fertilizer, and other approved additives and remains uniformly suspended under agitation. Color the mulch with a water-soluble, nontoxic dye to aide visual metering during application. Apply the mulch to produce a mat-like cover on the seeded ground.

At least 30 percent of the mulch fibers must average 0.15- inches (4 mm) or longer with 50 percent or more retained on a Clark Fiber Classifier 24-mesh screen.

Furnish wood cellulose fiber mulch meeting Table 713-5 requirements.

TABLE 713-5
WOOD CELLULOSE FIBER MULCH
PHYSICAL AND CHEMICAL PROPERTIES

PROPERTY	LIMIT	TOLERANCE
Moisture Content (total wt basis)	12%	± 3%
Organic Matter (oven-dried wt basis)	99.2%	± 0.2%
Inorganic Content (Ash)	0.8%	± 0.2%
Min. Water-holding Capacity (oven-dried wt basis)	1080 g/minute	100 g/minute

Supply the mulch in 50 pound (22.7 kg) bags net weight. Each bag must be marked by the manufacturer showing the air-dry weight content.

Supply a minimum one pound (0 454 kg) bag of the mulch proposed for use for testing when requested.

Provide a manufacturer's certificate of compliance under Subsection 106.03, attesting that the material meets these specifications.

713.10.5 Recycled Paper Fiber Mulch. Recycled paper fiber mulch is waste paper of at least 85% by weight, cellulose fiber. The mulch must:

1. Not contain any germination or growth inhibiting material nor non-biodegradable material;
2. Contain at least 95% organic matter (ovendry) when tested under ASTM D 586;
3. Have a pH of between 5.5 and 7.5;
4. Supplied in the manufacturers packages, clearly marked showing the package weight and contents;
5. Packaged mulch moisture content cannot exceed 15% by weight.

The mulch, when mixed with water and fertilizer and agitated, must be a uniform, homogenous mixture. The mulch or slurry must contain a green non-toxic dye making the mulch clearly visible once applied.

Apply the mulch hydraulically to form a moisture retaining surface that holds the seed in contact with the ground without smothering the seed.

713.11 SOD. Furnish sod that is a living, vigorous growth of grass of the type and thickness specified.

Provide sod native to the general locality of the project, having a dense root system, is free of noxious weeds, noxious grasses, and other foreign substances harmful to the development and maintenance of the sod.

Cut the sod when the grass length is approximately 2-inches (50 mm) high but not exceeding 3-inches (75 mm). Assure the sod is free of debris before cutting.

Wet the sod to permit cutting, rolling, and hauling without crumbling or breaking.

Water the sod using water from a municipal, domestic, or other source suitable for irrigation.

713.12 SOIL RETENTION/EROSION CONTROL BLANKETS AND MATS.

713.12.1 Wood Excelsior Fiber Blankets.

Type EX 1. Type EX 1 wood excelsior fiber blanket is a machine produced mat uniform in thickness and weighing at least 1 pound per square yard (545 g per m^2). The top side of the blanket must be covered with a photo-degradable extruded plastic mesh netting.

Type EX 2. Furnish Type EX 2 wood excelsior fiber blankets meeting the requirements of Type EX 1. Sandwich blankets between a high strength extruded plastic mesh netting.

Type EX 3. Type EX 3 wood excelsior fiber blanket is a machine produced mat of cured wood excelsior meeting the following requirements:

1. Minimum weight of 1.6 pounds per square yard (86 g per m^2);
2. Minimum width of 36-inches (915 mm);
3. Minimum roll length of 80 feet (24.4 m);
4. Eighty percent of the wood fibers must be at least 6-inches (155 mm) long, evenly distributed throughout the mat;
5. Encased top and bottom with a high strength plastic mesh netting that resists ultraviolet breakdown.

713.12.2 Straw Blankets.

Type ST 1. Type ST 1 straw blanket is a machine produced mat:

1. Made from 100% clean agricultural straw weighing a minimum 0.50 pounds per square yard (270 g per m^2) with a uniform thickness throughout the blanket;
2. The top side covered with a lightweight photo-degradable polypropylene net weighing approximately 1 pound per 1000 square feet (488 g per 100 m^2).

Type ST 2. Type ST 2 straw blanket meets Type ST 1 requirements and the following:

1. Sandwiched between a top cover of heavyweight UV resistant polypropylene netting weighing approximately 3 pounds per 1000 square feet (1,460 g per 100 m^2) and on the bottom cover of a lightweight photo-degradable polypropylene netting weighing approximately 1 pound per 1000 square feet (485 g per 100 m^2).

Type STC. Furnish Type STC blanket that is a machine produced mat:

1. Of 70% agricultural straw weighing 0.35 pounds per square yard (190 g per m^2) and 30% coconut fiber weighing 0.15 pounds per square yard (82 g per 100 m^2).
2. Having a uniform thickness with the straw and coconut evenly distributed within the mat.
3. Be sandwiched between a top heavy weight, UV resistant polypropylene netting weighing approximately 3 pounds per 1000 square feet (1460 g per

100 m²) and the bottom being a lightweight photo-degradable polypropylene netting weighing approximately 1 pound per 1000 square feet (485 g per 100 m²).
4. Sewn together with durable thread.
5. Treated to sterilize all weed seed.

Provide the Project Manager a manufacturer's certification stating the blankets supplied for the project have been sterilized and a statement detailing the method of sterilization used, before the blanket is installed on the project.

713.12.3 JUTE MAT. Type JUTE mat must be:
1. New unbleached jute yarn, uniformly open weaved.
2. Loose twisted yarn not varying in thickness by more than one half its nominal diameter.
3. Having a minimum yarn warp count of 78 per width and a minimum weft of 41 per linear yard (0.9 m).
4. Weighing 0.92 pounds per square yard (500 g per m²) (untreated) and 0.97 pounds per square yard (528 g per m²), treated to be smolder resistant.

713.12.4 COCONUT MAT AND BLANKETS.
A. **Type C Coconut Mat.** Type C mat is:
   1. Coconut mat made of 100% coconut fiber woven into a high strength matrix.
   2. Has a minimum weight of 0.8 pounds per square yard (0.43 kg /m²).
B. **Coconut Blanket.** Coconut Blanket is:
   1. A 100% coconut fiber matrix sewn between two heavyweight UV stabilized nets.
   2. Weighing a minimum 0.5 pounds per square yard (0.27 kg/m²).

713.12.5 Synthetic Polypropylene Mesh. Furnish a mesh made from polypropylene fibers spun in one direction and meeting the following:
1. Beige or Natural in color;
2. Minimum weight measured under ASTM D 3776 of 2.25 oz/yd² (76 g/m²);
3. Tensile strength measured under ASTM D 4632 of 225 X 120 lb/ft (3280 X 1750 N/m);
4. Elongation at break measured under ASTM D 1682 of 32 percent by 40 percent;
5. Mullen burst strength measured under ASTM D 3786 of 120 psi (827 kPa).

713.12.6 Polypropylene Roving. Furnish polypropylene roving from continuous strands of fibrillated polypropylene yarn. Wind the roving into a cylindrical package so the roving can be continuously fed from outside of the package through a compressed air injector and expanded into a mat of polypropylene strands. The material must not contain agents toxic to plant or animal life and meet the following requirements:
1. Contain 20 to 28 strands per rove measured by end count;
2. Have a fiber diameter, denier of 360, by calculation;
3. Rove of 170-515 yards per pound (340-1050 km/kg) (ASTM D 1907);

4. Strand of 12,400 to 14,000 yards per pound (25-28.2 km/kg) (ASTM D 1907);
5. A maximum 1 percent organic content (ASTM D 1907);
6. A package weight of 18 to 25 pounds (8-11 kg).

713.12.7 Synthetic Erosion Control and Revegetation Mat. Furnish a flexible mat of polyolefin monofilament fibers positioned between 2 biaxially oriented nets and mechanically bound together by parallel stitching with polyolefin thread to form a 3 dimensional web-like weave, highly resistant to environmental and chemical deterioration, and meeting the following:

1. Green in color;
2. Minimum mat thickness of 0.125-inch (3 mm) measured under ASTM D 1777;
3. A minimum tensile strength of 108 X 36 lbs/ft (1580 X 525 N/m), measured under ASTM D 1682;
4. Maximum elongation[1] of 150 percent by 100 percent, measured under ASTM D 1682;
5. Calculated[2] minimum porosity of 85 percent;
6. Resiliency[3], measured under ASTM D 1777 of 80 percent;
7. Ultraviolet[4] stability measured under ASTM D 4355, of 80 percent.

Notes:

[1] Values for both machine and cross machine directions under dry or saturated conditions. Machine direction specimen for 2-inch (50 mm) strip test includes one machine direction polyolefin stitch line centered within its width and extending the full length of the specimen.

[2] Calculation based upon weight, thickness, and specific gravity.

[3] The percent of original thickness retained after 3 cycles of a 100 psi (690 kPa) load for 60 seconds followed by 60 seconds without load. Thickness measured 30 minutes after load removed.

[4] Tensile strength retained after 1,000 hours in an Xenon ARC weatherometer.

713.12.8 Turf Reinforcement Mat. Furnish a web of mechanically or melt bonded polymer netting, monofilaments, or fibers that are entangled to form a strong and dimensionally stable mat. Bonding methods include polymer welding, thermal or polymer fusion, or the placement of fibers between 2 high-strength, biaxially oriented nets mechanically bound together by parallel stitching with polyolefin thread. The mat must be resistant to biological, chemical, and ultra-violet degradation and meet the following:

1. Black in color;
2. Minimum mat thickness of 0.50-inch (13 mm), measured under ASTM D 1777;
3. Minimum tensile strength[1] of 94 X 54 lb/ft (1370 X 790 N/m), measured under ASTM D 1682;
4. Maximum elongation[1]of 75 percent by 75 percent, measured under ASTM D 1682;
5. Minimum calculated[2] porosity of 90 percent;

6. Resiliency[3] of 80 percent, measured under ASTM D 1777;
7. Ultraviolet stability[4] of 80 percent, measured under ASTM D 4355.

Note:

[1] Values for both machine and cross machine directions under dry or saturated conditions using 2-inch (50 mm) strip method.
[2] Calculation based upon weight, thickness, and specific gravity.
[3] The percent of original thickness retained after 3 cycles of a 100 psi (690 kPa) load for 60 seconds followed by 60 second without load. Thickness measured 30 minutes after load removed.
[4] Tensile strength retained after 1,000 hours in an Xenon ARC weather-ometer.

713.13 GEOSYNTHETICS. Furnish geosynthetics meeting the requirements in Table 713-1 and the Contract. Store and protect the material following the manufacturer's recommendations. Any material left exposed to the sun 10 days or longer cannot be used in the work.

TABLE 713-1
GEOTEXTILES & GEOMEMBRANES

PROPERTY	TEST METHOD	GEOTEXTILES						GEOMEMBRANES			
		DRAINAGE		EROSION CONTROL		SEPARATION / STABILIZATION		SEDIMENT CONTROL	PAVING	LIQUID/VAPOR BARRIER	
		LIGHT	HEAVY	CL I	CL II&III	MEDIUM SURVIVABILITY	HIGH SURVIVABILITY			LIGHT	HEAVY
Grab Strength (lbs.)	ASTM D 4632	80	180	90	200	180/115 **	270/180 **	90	80	—	—
Grab Elong %	ASTM D 4632	—	—	15	15	<50%/≥50% **	<50%/≥50% **	50% Max @ 45 lbs.	50% @ Break	—	—
Puncture 60 (lbs.)	ASTM D 4833	25	80	40	80	70/40 **	100/75 **	—	—	30 ***	60 ***
Trap Tear (lbs.)	ASTM D 4533	25	50	30	50	70/40 **	100/75 **	—	—	—	—
App. Opening Size (Sieve Size)	ASTM D 4751	50 Max.	30 Max	40 Max	40 Max	40 Max	40 Max	20 Max	—	—	—
Flow Gas/Min/Ft²	ASTMD 4491 (MOD.)	80	80	70	25	*	*	15	—	0.0	0.0
Ultraviolet Deg. 70% Ret. Strength	ASTM D 4355	150 Hrs	150 Hrs	150 Hrs	150 Hrs	150 Hrs	150 Hrs	500 Hrs	—	—	—
Melting Point (Deg. F)	ASTM D 276	—	—	—	—	—	—	—	300	—	—
Asphalt Ret. (Gal/Yd²)	AASHTO M 288	—	—	—	—	—	—	—	0.2	—	—
Thickness Mils (1 mm=40 mils)	ASTMD 3765 (MOD.)	—	—	—	—	—	—	—	—	30	60

NOTES (TABLE 713-1):

ACCEPTANCE All values are minimum roll average values. Acceptance will be in accordance with ASTM D 4759.

DRAINAGE Light - use for sandy to clayey soils.
Heavy - use for coarse sands and gravels.

* FLOW Flow rates will be specified in the Special Provisions.

** SEPARATION/STABILIZATION Geotextiles with <50% elongation require the higher grab, puncture and trap tear strength values.

*** GEOMEMBRANE Test method for puncture will be in accordance with FTMS 101C-Method 2065.

TABLE 713-1 Metric
GEOTEXTILES & GEOMEMBRANES

GEOTEXTILES — GEOMEMBRANES

PROPERTY	TEST METHOD	DRAINAGE		EROSION CONTROL		SEPARATION / STABILIZATION		SEDIMENT CONTROL	PAVING	LIQUID/VAPOR BARRIER	
		LIGHT	HEAVY	CL I	CL II&III	MEDIUM SURVIVABILITY	HIGH SURVIVABILITY			LIGHT	HEAVY
Grab Strength (kg)	ASTM D 4632	36.3	81.7	40.9	90.8	81.7/82.2 **	122.6/81.7 **	40.9	36.3	—	—
Grab Elong %	ASTM D 4632	—	—	15	15	<50%/≥50% **	<50%/≥50% **	50% Max @ 20.4 kg	50% @ Break	—	—
Puncture (kg)	ASTM D 4833	11.3	36.3	18.2	36.3	31.8/18.2 **	45.4/34 **	—	—	13.6 ***	27.2 ***
Trap Tear (kg)	ASTM D 4533	11.3	22.7	13.6	22.7	31.8/18.2 **	45.4/34 **	—	—	—	—
App. Opening Size (Sieve Size)	ASTM D 4751	50 Max.	30 Max	40 Max	40 Max	40 Max	40 Max	20 Max	—	—	—
Flow L/Min/m²	ASTM D 4491 (MOD.)	3256	3256	2849	1017	*	*	611	—	0.0	0.0
Ultraviolet Deg. 70% Ret. Strength	ASTM D 4355	150 Hrs	150 Hrs	150 Hrs	150 Hrs	150 Hrs	150 Hrs	500 Hrs	—	—	—
Melting Point (Deg. C)	ASTM D 276	—	—	—	—	—	—	—	148.8	—	—
Asphalt Ret. (L/m²)	AASHTO M 288	—	—	—	—	—	—	—	0.9	—	—
Thickness mm (1 mm=40 mils)	ASTM D 3765 (MOD.)	—	—	—	—	—	—	—	—	.75	1.5

NOTES (TABLE 713-1 Metric):

ACCEPTANCE All values are minimum roll average values. Acceptance will be in accordance with ASTM D 4759.

DRAINAGE Light - use for sandy to clayey soils.
Heavy - use for coarse sands and gravels.

* FLOW Flow rates will be specified in the Special Provisions.

** SEPARATION/STABILIZATION Geotextiles with <50% elongation require the higher grab, puncture and trap tear strength values.

*** GEOMEMBRANE Test method for puncture will be in accordance with FTMS 101C-Method 2065.

SECTION 714
PAVEMENT MARKING MATERIALS

714.01 TEMPORARY PAVEMENT MARKING TAPE. Furnish temporary pavement marking tape that is 4-inch (105 mm) wide, retro-reflective, pressure-sensitive tape specifically manufactured for use as pavement stripping. The tape must be available in white and yellow.

714.02 TEMPORARY PAVEMENT MARKING TABS. Furnish temporary pavement marking tabs meeting the following:

1. Types I and II: "L" shaped, extruded polyurethane, at least 4-inches (105 mm) wide by 2-inches (50 mm) high with a reflectorized strip meeting requirement No. 4 below; attached horizontally across the top of the vertical portion of the tab; an adhesive strip meeting requirement No. 5 below;
2. Type I tabs: white reflectorized tape on one side with white bodies;
3. Type II tabs: yellow reflectorized tape on both sides with yellow bodies;
4. A minimum tape reflectance of 1200 candlepower per square foot (138,892 lux per m^2) at 0.1 degrees observation and 0.0 degrees entrance angles;
5. An adhesive strip at least ¾-inch wide by ⅛-inch thick (19 mm X 3 mm) on the tabs underside;
6. A cover protecting the reflective strip that will not come off under traffic but is manually removable.

714.03 PREFORMED PLASTIC PAVEMENT MARKING MATERIAL.

714.03.1 Composition Requirements. Furnish preformed plastic pavement marking material consisting of plastics and plasticizer's, pigments, and reflective glass beads combined and proportioned to meet the following:

1. Available in both yellow and white color;
2. The total pigment in white marking material a minimum 20% by weight titanium dioxide;
3. The total pigment in yellow marking material a minimum 18% by weight medium chrome yellow;
4. Marking material colors that match the Federal Standard Highway Color #595 A, 33538 for yellow, 37925 for white;
5. Non-yellowing white material;
6. non-fading yellow material during the expected life of the materials;
7. Having reflective glass beads meeting Subsection 714.05 requirements uniformly distributed throughout the entire material.

714.03.2 Adhesive Requirements. Furnish material having a pre-coated pressure-sensitive adhesive on the base to adhere to bituminous and portland cement concrete pavements. The adhesive must:

1. Be sufficiently free of tack so the material can be handled or repositioned on the pavement before being permanently fixed in position;
2. Mold to the pavement contours, breaks, faults under traffic at normal pavement temperatures;

3. Reseal itself so that, under normal use, it will fuse with itself and previously applied markings of similar composition;
4. Capable of being inlaid in pavement at temperatures up to 275 °F (135 °C);
5. Not lose its adhesive and reflective properties when exposed to water used in rolling operations.

714.03.3 Dimensional Requirements. Furnish the pavement marking material in standard manufactured widths of 4, 6, 8, 12, and 24-inches (105, 155, 205, 305, & 610 mm).

Furnish the material for words and symbols in pre-cut configurations matching the shapes and dimensions specified in the publication "Standard Alphabets for Highway Signs and Pavement Markings".

Furnish the pavement marking material in the thickness specified in the Contract.

Cut the edges of plastic pavement marking material clean and true.

714.03.4 Physical Requirements.

A. **Tensile Strength.** Furnish plastic material having a minimum tensile strength of 40 psi (276 kPa) when tested under ASTM D 638. The break resistance is based on an average of at least 3 samples tested at a temperature of 70 °F-80 °F (21 °C-27 °C) using a jaw speed of 0.25-inch (6 mm) per minute.

B. **Plastic Pull Test.** A 1 by 6-inch (25 X 155 mm) sample of the plastic material must support a dead weight of 0.66 pounds per 0.01-inch (1.2 kg per mm) of material thickness for at least 5 minutes at a temperature of 70 °F-80 °F (21 °C-27 °C).

C. **Bend Test.** At 80 °F (27 °C) bend a 3 by 6-inch (75 X 155 mm) sample over a 1-inch (25 mm) diameter mandrel until the end faces are parallel and 1-inch (25 mm) apart. The sample must not show any fracture lines in the uppermost surface under unassisted visual inspection.

D. **Skid Resistance.** The plastics surface friction properties must be at least 35 BPN when tested under ASTM E 303.

E. **Reseal Test.** The plastic must re-seal itself without adhesives when tested as follows: Overlap two 1 X 3-inch (25 X 75 mm) pieces face-to-face forming a single 1 X 5-inch (25 X 130 mm) piece with a 1 square inch (645 mm^2) overlap in the center. Place the 1 X 5-inch (25 X 130 mm) piece on a hard surface with a 1000-gram weight resting uniformly on the entire overlap area and maintain at 140 °F-190 °F (60 °C-88 °C) for 2 hours. Maintain the temperature within the specified range. Cool to room temperature. The pieces must not separate without tearing.

F. **Reflectivity.** Meet the reflective values listed in Table 714-1. Reflective values will be measured on a 2 X 2½ foot (610 X 762 mm) panel under the Instrumental Photometric Measurements of Retro-reflective Materials and Retroflective Devices, Federal Test Method Standard 370.

TABLE 714-1
MINIMUM SIA* (CANDELAS PER FOOTCANDLE PER SQUARE FOOT (M^2))
PLASTIC PAVEMENT MARKING MATERIAL

Observation Angle	Entrance Angle	White	Yellow
0.2°	86°	0.20 (2.1)	0.15 (1.6)
0.5°	86°	0.15 (1.6)	0.10 (1.0)

* SIA - Specific Intensity Per Unit Area

714.03.5 Samples. Submit a 4-inch by 1 foot (105 X 305 mm) sample from each lot of material proposed for use on the project to the Materials Bureau for approval. Obtain approval before using in the work.

714.03.6 Certification. Submit to the Project Manager the manufacturer's certification meeting Subsection 106.03. Include evidence from the manufacturer that the material proposed for use in the work has performed successfully under similar climatic conditions and traffic usage. This evidence of successful use is required for the product to be approved for use.

714.04 TRAFFIC LINE PAINT.

714.04.1 General. The class, type, and brand of paint ingredients is the manufacturers option. Samples of the ingredient materials may be required by the Project Manager. All materials must meet the applicable ASTM specifications and the following requirements.

714.04.2 Manufacture. Grind and mix the ingredient materials to produce a homogeneous paint, free of deleterious material. Furnish to the Department's inspector, the manufacturer's equipment and paint manufacturing process.

714.04.3 Analysis. Furnish 3 notarized copies of the paint analysis and manufacturer's certification under Subsection 106.03. The analysis must state the complete composition and percentages of each of the raw materials in the paint. Formulation's are treated confidentially and are not released without the manufacturers consent.

714.04.4 Pigment. Use inorganic colors and white pigment to produce the specified yellow.

Yellow paint, less beads, must contain at least 1.5 lbs per gallon (0.18 kg/L) total chromium as $PbCrO_4$ in the form of medium chrome yellow type **III**. Chromium content is determined by chemical analysis of the extracted pigment.

White paint, less beads, must contain a minimum of 1.5 lbs per gallon (0.18 kg/L) titanium dioxide as determined from the chemical analysis of total titanium dioxide in the extracted pigment.

714.04.5 Vehicle. Use an alkyd resin meeting the following specifications:

Nonvolatile	59-61%
Volatile	Mineral spirits or VM&P naptha
Viscosity (Gardner Holdt)	z-z-4
Acid No. of Solution	10 Max.
Color (Gardner 1933 Std.)	9 Max.
Specific Gravity of Solution	.920-.950

The non-volatile vehicle must be an alkyd resin consisting only of :

Polyhydroxyl Alcohol	15-21%
Phthalic Anhydride	30-40%
Drying Oil Acids	45-60%

The resin must:

1. Not exceed 1% unsaponifiable matter by weight;
2. Must show a negative resin test and a negative phenolic compound test;
3. Limit the drying oils to linseed and /or soybean oil.

714.04.6 Color. A standard color chip will be furnished each bidder for the yellow and white traffic line paint upon request.

714.04.7 Testing. Paint is tested by ASTM, Federal Test Method Standard No. 141, or alternate tests approved by the Engineer.

Meet the following test results:

A. **Viscosity** — 70 (±5) Krebs Units after 4 days from manufacture at 77 °F (25 °C) and less than 90 Krebs Units at 41 °F (5 °C) when tested under ASTM 562.
B. **Drying Time** — When tested under Federal Test Method Standards 141C, method 4061.2, no pickup after 10 minutes and before 30 minutes and dry hard within 1 hour.
C. **Bleeding** — no bleeding or discoloration.
D. **Water Test** — no blistering, peeling, or wrinkling.
E. **Flexibility** — no cracking.
F. **Adhesion** — no cracking, chipping, or peeling.
G. **Fineness** — greater than 3 when tested using the North Standard Fineness Gauge.
H. **Skinning** — no skinning in a half-filled pint (0.47 L) container in under 24 hours.
I. **Settling** — no settling or caking in the container during extended storage. An accelerated evaluation method is included in the test.
J. **Abrasion** — no paint film loss exceeding 1/10 gram per 1000 revolutions using the Taber Abrasion Test.
K. **Hiding** — completely hide black when applied at 1 gallon per 175 square feet (0.23 L per m^2).
L. **Film Appearance** — Dry to a flat finish.
M. **Light Resistance** — Yellow paint must not darken.

714.04.8 Sampling and Acceptance of Materials. Traffic paint is sampled from the striping machine paint tank, before work begins, at the point of application.

Draw samples, when directed, in sample containers furnished by the Inspector. Furnish all required assistance for sampling. Samples not witnessed by the Inspector are not acceptable for testing. Paint not meeting the specifications cannot be used in the work.

714.04.9 Packaging and Marking. Ship paints in the paint manufacturer supplied containers. Damaged paint containers received at the project site will be rejected. Assure each container is labeled with the name and address of the manufacturer, shipping point, trademark or trade name, kind of paint, formula or formula number referring to manufacturer's guaranteed formula, number of gallons (liters), date, and batch numbers.

714.05 REFLECTIVE GLASS BEADS.

714.05.1 General. Furnish glass beads for drop-on reflectorizing traffic paint that are spherical and transparent with a smooth, lustrous surface. The delivered beads must be free from extraneous material and bead clumps that do not easily break up while handling and distributing onto the stripe.

714.05.2 Imperfections. The glass beads must:

1. Not contain more than 25% irregularly shaped particles when tested under ASTM D 1155;
2. Not be scratched, pitted, milky, contain dark particles, or excessive air bubbles.

714.05.3 Color. The glass beads must not impart a noticeable daytime hue to white pavement markings.

714.05.4 Chemical Stability. The beads must withstand refluxing in distilled water in a Soxhlet extractor for 90 hours without noticeable dulling of the surface luster and not more than 2.5% loss in weight.

714.05.5 Index of Refraction. The glass from which the beads are manufactured must have a minimum refraction index of 1.50 by the immersion method using tungsten light.

714.05.6 Gradation. Meet the following gradations when tested under ASTM D 1214.

Sieve No:	Percent Passing
20 (0.850 mm)	100%
30 (0.600 mm)	75-95
50 (0.300 mm)	15-35%
100 (0.150 mm)	0-5%

714.05.7 Packaging and Marking. Package glass beads in moisture-proof containers marked to identify the contents, manufacturer, lot number, batch number and net weight.

714.05.8 Samples. Glass beads will be sampled for acceptance at the source of supply. The Contractor is to make sample arrangements with the Materials Bureau in Helena, (406-444-6298). The Department will issue the test results, identifying each lot or batch tested, and identifying each lot or batch as acceptable or unacceptable. The Project Manager will provide, upon request, a list identifying the acceptable lots or batches that may be used in the work.

714.06 REFLECTIVE THERMOPLASTIC PAVEMENT MARKINGS.

714.06.1 General. Furnish white and yellow thermoplastic marking material that is hydrocarbon-based. Meet AASHTO M 249 except as modified and supplemented herein.

714.06.2 Color. Furnish yellow marking material matching color chip 33538 of Federal Standard No. 595a, Table 5.

Furnish white marking material matching color chip 37875 of Federal Standard No. 595a, Table 9.

White material must have no tint or coloration after weathering.

714.06.3 Glass Beads. Furnish glass beads meeting Subsection 714.05 requirements.

Submit to the Project Manager, a manufacturer's certification under Subsection 106.03 that the glass beads supplied meet specifications.

714.06.4 Spraying Consistency. Applying Hot Thermoplastic marking material by spraying must be not adversely effect the specified reflectivity, durability, color, line and edge quality, tolerances, thicknesses, and bonding requirements.

714.06.5 Requirements for Hydrocarbon-Based Materials. Meet AASHTO M 249 requirements for hydrocarbon-based thermoplastic marking material, modified and supplemented as follows:

- **A. Specific Gravity.** Cannot vary from the manufacturer's product specification by more than 0.05.
- **B. Composition.** Table 1, Composition, of AASHTO M 249 is replaced with Table 714-2.

TABLE 714-2
COMPOSITION

COMPONENT	WHITE	YELLOW
Binder, Hydrocarbon Base	16.0% min.	16.0% min.
Glass Beads	25% min.	25% min.
Titanium Dioxide	Anatase 5.0% min Rutile	-------
Calcium Carbonate and Inert Fillers	5.0%min 42% max.	-------
Yellow Pigments	--------	See Note

Note: The quantity of yellow pigments, calcium carbonate, and inert fillers is the manufacturer's option providing all other requirements of this specification are met.

Furnish a manufacturer's certification under Subsection 106.03 that the titanium dioxide contains a minimum of 5.0% each of anatase and rutile for all batches of material supplied on the project.

C. Modifications. The following modifications are made to Subsections 4.3, 5., and 6. of AASHTO M 249:

4.3 Physical Characteristics: 4.3.1, 4.3.2, 4.3.3, 4.3.4, 4.3.5, 4.3.6, 4.3.7, 4.3.9 Wherever the temperatures "211° ± 7°C (412.5° ± 12.5°F)" and "218° ± 2°C (425° ± 3°F)" appear in the above-listed subsections, add "or the manufacturer's recommended application temperature range".

4.3.4 Change "-9.4° ± 1.7°C (15° ± 3°F)" to "-20°C (-4°F)". Add to the last sentence: "after being exposed to ambient room temperature of 20°-23°C (68°-74°F) after cooling."

4.3.5 Change 218° ± 2°C (425° ± 3°F) to manufacturer's recommended application temperature.

5. Application Properties: 5.1 After "211° ± 7°C (412.5° ± 12.5°F)" add "or as recommended by the manufacturer".

6. Packaging and Marking: 6.1 Rescind the last sentence and replace with the following: "The label shall show the manufacturer's recommended application temperature range".

714.06.6 VACANT.

SECTION 715
TRAFFIC CONTROL DEVICES

715.01 Signs and Channelizing Devices. Meet the Detailed Drawings and MUTCD requirements.

Construction signs may be horizontally hinged at the midpoint of the sign face provided the hinge gap does not exceed 1/2-inch (13 mm) and the sign legend is legible.

715.02 PORTABLE SIGN SUPPORT ASSEMBLIES. Construct portable sign support assemblies from lightweight yielding material. Meet the following requirements:

A. Use wood members with a maximum 16 square inch (10.3 m^2) cross section for base construction and 8 square inch (5.2 m^2) cross section for uprights and braces.

B. Use tubular metal members with a maximum 9 square inch (5.8 m^2) cross section.

C. Use solid metal members with a maximum 1 square inch (645 mm^2) cross section.

Portable signs may be trailer mounted if:

1. The weight of the trailer assembly does not exceed 250 pounds (113.5 kg);
2. The axle, frame, support assembly, and other structural members cannot exceed the dimensions of the portable sign support assembly;
3. The trailer tire outside diameter does not exceed 28-inches (715 mm). Automotive and equipment axle assemblies cannot be used for trailer-mounted sign supports.

715.03 ADVANCE WARNING ARROW PANELS. Furnish advance warning arrow panels (arrow boards) that meet the requirements of MUTCD, Section 6E-9. Each arrow board must have at least 25 lamps.

Use 36 x 72-inch (915 X 1,830 mm) Type "B" Arrow boards on striping units and shadow vehicles. Use Type "C", 48 x 96-inches (1,220 X 2,440 mm) for all other applications.

Equip the arrow board with a dimming device to automatically reduce the intensity of the flasher at night.

715.04 WARNING LIGHTS. Equip all vehicles, hauling units, and mobile construction equipment operating within the project limits and operating on roadways used by the traveling public with an amber flashing or strobe light visible from all directions for at least 0.4 mile (0.6 km) during daylight and clear weather conditions.

715.05 ADVANCE FLAGGER AHEAD WARNING SIGNS. Equip the W20-7a (advance flagger ahead) sign with two 12-inch (305 mm) amber signals, each mounted 36-inches (915 mm) from the center of the sign panel on a line 45 degrees above horizontal. Provide each lens with a 22 x 22-inch (560 X 560 mm) square backplate with a dull black finish and a 12-inch (305 mm) cut-away tunnel visor. Use 116 watt traffic signal light bulbs. Furnish 115/120 V.A.C. electrical current to the

flasher unit. Assure the signals flash alternately and continuously at a rate of not less than 50 nor more than 60 times per minute. The illuminated period of each flash must be not less than one-half nor more than two-thirds of the total flash cycle.

Meet Subsection 715.02 requirements for mounting portable sign support assemblies.

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